

Operation Manual for **MTP Series Magnetic Levitation Molecular Pump**



VACUUM PUMP



VACUUM VALVE



VACUUM COMPONENT



VACUUM MEASUREMENT



VACUUM CHAMBER

TABLE OF CONTENTS

1 product description

1.1 Composition of product code--	2
1.2 cell structure--	4
1.2.1 Names and functions of various components--	4
1.2.2 Name and function of the standard controller--	6
1.3 Technical Parameter--	7
1.3.1 Specifications of MTP pump--	7
1.3.2 Maximum gas flow rate--	8
1.3.3 controller--	8
1.3.4 Inlet fixing bolt--	10
1.3.5 bake--	10
1.3.6 corrosion preventive--	10
1.4 Overall dimensions--	10
1.5 check and accept--	14
1.6 install--	16
1.6.1 clean--	16
1.6.2 Installation environment--	16
1.6.3 installation area--	16
1.6.4 installation direction--	16
1.6.5 External power supply--	17
1.6.6 vacuum line--	17
1.7 Water cooling--	17
1.7.1 Service conditions of cooling water--	18
1.7.2 Connection method of water-cooled tube--	18
1.8 TMS (Temperature Management System) function (optional)--	19
1.8.1 Technical parameters of TMS function--	19
1.8.2 Electrical connection of TMS function--	19
1.8.3 Cooling unit connection for TMS function--	20
1.9 Purging function (optional)--	20
1.10 Precautions for semiconductor applications--	21

2 Operating Instructions

2.1 start--	22
2.1.1 Confirmation items--	22
2.1.2 Backing Pump--	22
2.1.3 power on--	22

2.2 operate-----	22
2.2.1 operating mode-----	22
2.2.2 Start/Stop-----	22
2.3 Shutdown and restart-----	24
2.3.1 Restart during shutdown process-----	24
2.3.2 Restart after protection-----	25
2.3.3 shutdown-----	25
2.4 LED-----	25
2.5 REMOTE-----	26
2.5.2 Remote control operation port settings-----	29
2.5.4 Prohibit starting function-----	31
2.5.5 REMOTE control output port-----	31
2.6 TMS function (optional)-----	33
2.6.1 inspect-----	33
2.6.2 Start/Stop-----	33
2.6.3 working process-----	33

3 Serial communication protocol

3.1 brief introduction-----	34
3.2 set up-----	34
3.2.1 Communication Port-----	34
3.2.2 Recommendations for communication cables-----	35
3.2.3 rs485 communication-----	36
3.2.4 Factory parameters and settings-----	37
3.2.5 Communication port setting-----	38
3.2.6 Serial communication timeout setting-----	38
3.3 Communication protocol-----	38
3.3.1 General description-----	38
3.3.2 Transmission data format-----	39
3.3.3 Frame control (checksum)-----	39
3.3.4 control error-----	40
3.3.5 RS232/RS485 single-point connection: standard transmission frame-----	40
3.3.6 RS232/RS485 single-point connection: control command-----	41
3.3.7 RS232/RS485 single-point connection: query command-----	43
3.3.8 RS485 multi-drop connection: standard transmission frame-----	44
3.3.9 RS485 multi-drop connection: control command-----	45
3.3.10 RS485 multi-point connection: query command-----	46
3.3.11 RS485 multi-drop connection: broadcast command-----	47
3.3.12 precautions-----	48

3.4 Command specification	51
3.4.1 Function code list	51
3.4.2 Read real-time rotational speed	52
3.4.3 Issue operation command	52
3.4.4 Read real-time error information	53
3.4.5 Read operation mode and real-time error information	56
3.4.6 Read the target rotational speed and the set value of TMS target temperature	57
3.4.7 Read the temperature value of the motor	57
3.4.8 Read the settings of the control port, TMS, and emergency exhaust valve	58
3.4.9 Set the target rotational speed setting value	59
3.4.10 Read the set value of target rotational speed	60
3.4.11 Read operation mode, errors, and alarms	60
3.4.12 Read the current error record	62
3.4.13 Read the status of TMS, motor, and controller	63
3.4.14 Read optional functions	64
3.4.15 Set optional functions	65
3.4.16 Read the status of the molecular pump	67
3.4.17 Read historical error records	68
3.4.18 Set the second speed function parameter	71
3.4.19 Read the second speed functional parameter	72

4 PROFIBUS communication protocol (optional)

4.1 Introduction to PROFIBUS Communication	74
4.1.1 overview	74
4.1.2 Setting Steps	74
4.1.3 PROFIBUS terminal	74
4.1.4 Baud rate setting	74
4.1.5 Connection method	74
4.1.6 PROFIBUS indicator light	75
4.1.7 PROFIBUS address	75
4.2 Software format	76
4.3 Software block	76
4.3.1 Block 01: MTP Pump Command	77
4.3.2 Block 02: MTP Pump Status	77
4.3.3 Block 03: Warning Information	78
4.3.4 Block 04: Fault Information	78
4.3.5 Block 05: Current operating speed	80
4.3.6 Block 06: Motor current	80
4.3.7 Block 07: Motor Temperature	80
4.3.8 Block 08: Control Unit Temperature	81
4.3.9 Block 18: Read target rotational speed	81
4.3.10 Block 22: Set target rotational speed	81

5 EtherCAT communication protocol (optional)

5.1 Introduction to EtherCAT communication function of MTP pump	82
5.2 Instructions for the EtherCAT version of the MTP pump	83
5.2.1 Unpacking	83
5.2.2 Electrical connection of front interface panel	83
5.2.4 Communication parameter setting of MTP pump	85
5.2.5 EtherCAT communication indicator light	85
5.2.6 EtherCAT communication ID rotary encoder	86
5.2.7 MTP pump operation port	87

5.3 MTP pump EtherCAT communication-----	87
5.3.1 Slave device description file-----	87
5.3.2 Instruction Description-----	87

6 Protection function

6.1 Protection function-----	90
6.1.1 Abnormal power loss of external power supply-----	90
6.1.2 Power off and then restart-----	91
6.1.3 Magnetic bearing anomaly-----	91
6.1.4 Excessive vibration (disturbance)-----	91
6.1.5 Motor drive overload-----	91
6.1.6 The MTP pump is internally overheated (motor overheating)-----	91
6.1.7 Internal overheating of the controller-----	92
6.1.8 speeding-----	92
6.1.9 Failure of TMS function (optional)-----	92
6.2 give an alarm-----	92
6.3 Alarm function-----	94
6.3.1 Primary damage limit-----	94
6.3.2 Secondary damage limit-----	94
6.3.3 Operation time exceeded-----	94
6.3.4 overload-----	94
6.3.5 imbalance-----	95
6.4 Alarm setting-----	95
6.5 Fault handling-----	96
6.5.1 Automatic power restoration-----	96
6.5.2 Other anomalies or alarms-----	96
6.6 Troubleshooting-----	97
6.6.1 Fault status indicator (no display)-----	97
6.6.2 Fault status indicator light (green)-----	98
6.6.3 Fault status indicator light (red)-----	98

7 Management and inspection

7.1 Maintenance and inspection-----	103
7.2 maintenance-----	103
7.2.1 maintenance-----	103
7.2.2 Replace protective components-----	104
7.2.3 Recommended maintenance intervals for main components-----	104
7.3 clean-----	105
7.4 transport-----	105

8 Storage and disposal

8.1 storage-----	106
8.2 Scrapping-----	106

Regarding the instruction manual

Safety Instructions for the MTP Series Integrated Smart Magnetic Suspension Molecular Pump (hereinafter referred to as MTP Pump)

To avoid personal injury and equipment damage, installation and operation personnel must carefully read this manual before installing and using the MTP pump, and follow the provisions specified in the manual for installation and operation.

This manual was first released on October 11, 2024, and is applicable to the MTP series integrated magnetic levitation molecular pumps and their subsequent improved models. Due to product technology improvements or other reasons, updates to the manual content may occur without further notice from our company. Please understand. The latest information can be found on the official website of Zhongke Jiuwei (website: www.mm-tech.com.cn) or by contacting our company.

The content of this manual has been rigorously reviewed. If there are any errors or omissions, please contact Zhongke Jiuwei Technology Co., Ltd.

The copyright of this manual, as well as all intellectual property rights related to " " arising from, generated by, and contained within this manual, belongs exclusively to Zhongke Jiuwei Technology Co., Ltd. No entity or individual is authorized to photocopy this manual, in whole or in part, without prior permission.

safety warning Instructions for Use

- To ensure the normal and stable operation of the MTP pump, please be sure to carefully read this manual before installation, commissioning, and operation, and strictly follow the protective measures described in the manual.
- Operators must be aware of the hazards associated with the operation of MTP pumps, as well as the inherent dangers of the gases being pumped by MTP pumps!
- It must be operated and maintained by trained personnel!

Personnel safety protection

	danger Be cautious of hazardous substances! During the operation of the MTP (Magnetic Suspension Molecular Pump), the gas extracted may contain corrosive, radioactive, or other toxic and harmful substances. Maintenance personnel must take protective measures when maintaining the MTP pump!
	warn Beware of falling! 1、 When handling MTP pumps with bare hands, be cautious to prevent them from slipping and falling, which could pose a danger! 2、 When handling the relatively lightweight MTP pump, please handle the inlet flange or the bottom of the pump body! 3、 When handling MTP pumps weighing more than 20kg, be sure to use handling tools!

**pay attention to**

Prevent burns!

1. During use, there is a possibility of heating the MTP pump. Please handle with care to avoid burns!
2. Before carrying out maintenance on the MTP pump, please ensure that the pump body and heating components have cooled down!

**pay attention to**

Prevent scratching!

1. The MTP pump and its controller may have sharp edges, please handle with care to avoid injury!

danger

- The gas extracted by the MTP pump may contain corrosive or radioactive substances. Maintenance personnel must take protective measures when overhauling the MTP pump to prevent personal injury caused by harmful substances remaining in the MTP pump!
- When handling, please ensure to avoid personal injury or equipment damage caused by slipping and falling. When the weight of the MTP pump exceeds 20kg, it is recommended to use a handling tool!
- Electrical connection operations must be performed by trained personnel, and it is essential to follow standardized procedures to strictly prevent electric shock!
- Before carrying out any maintenance and repair work on the MTP pump, be sure to disconnect the power supply to strictly prevent electric shock!

warn

- During the use of MTP pumps, the pump body may experience high temperatures. Operators should avoid direct contact with the pump body to prevent burns!
- When transporting MTP pumps, please use the original factory packaging!

pay attention to

- Prevent scratching by the MTP pump!

1 product description

Molecular pumps are used to evacuate enclosed vacuum chambers with molecular flow or near-molecular flow conditions. The MTP series integrated intelligent magnetic suspension molecular pump (hereinafter referred to as MTP pump) is a compound turbo molecular pump, featuring low vibration, low power consumption, corrosion resistance, high cleanliness, maintenance-free operation, long service life, and installation at any angle. It also boasts adjustable speed, auxiliary heating, power-off protection, status monitoring, fault alarm, and other functions, and is widely used in semiconductors, industrial coating, analytical instruments, scientific research, electric vacuum device manufacturing, and other fields of vacuum technology.

The certification certificates obtained for MTP pumps are summarized in the table below:

Table1 Summary of certifications obtained for MTP pumps

Certification item	describe
EN 1012-2:1996+A1:2009	Compressors and vacuum pumps - Safety requirements, Part 2: Vacuum pumps
EN 61010-1:2010+A1+AC	Safety requirements for electrical equipment used for measurement, control, and laboratory purposes - Part 1: General requirements
EN 60204-33:2011	Requirements for mechanical safety, electrical equipment of machinery, and semiconductor manufacturing equipment.
EN IEC 61000-4-11:2020	Electromagnetic Compatibility (EMC) Part 4-11: Testing and Measurement Techniques - Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests for Equipment with Input Current not Exceeding 16A per Phase
EN 60204-1:2018	Safety of Machinery - Electrical Equipment of Machines - Part 1: General Requirements
2006/42/EC	machinery directive
SEMI S2-0821	Environmental, Health, and Safety Guidelines for Semiconductor Manufacturing Equipment
SEMI S8-0218	Ergonomic Safety Guidelines for Semiconductor Manufacturing Equipment
SEMI F47-0706	Voltage sag immunity specification for semiconductor manufacturing equipment

1.1 Composition of product code

The MTP pump offers a range of models and optional features, allowing users to select the appropriate MTP pump based on their specific working conditions. A summary is as follows:

- (一) Models: MTP-1601, MTP-2201, MTP-3201, MTP-4301, etc;
- (二) Communication mode: MODBUS version (standard configuration), EtherCAT version (optional), PROFIBUS version (optional);
- (三) Corrosion resistance: anodizing (standard version), corrosion-resistant coating (optional version);
- (四) TMS function (temperature control system): without TMS (standard version), with TMS (optional version);
- (五) Purge: Without purge (standard version), with purge (optional version);
- (六) Flange port shape: ISO-F flange (standard version), CF flange (optional version), VG flange (optional version);

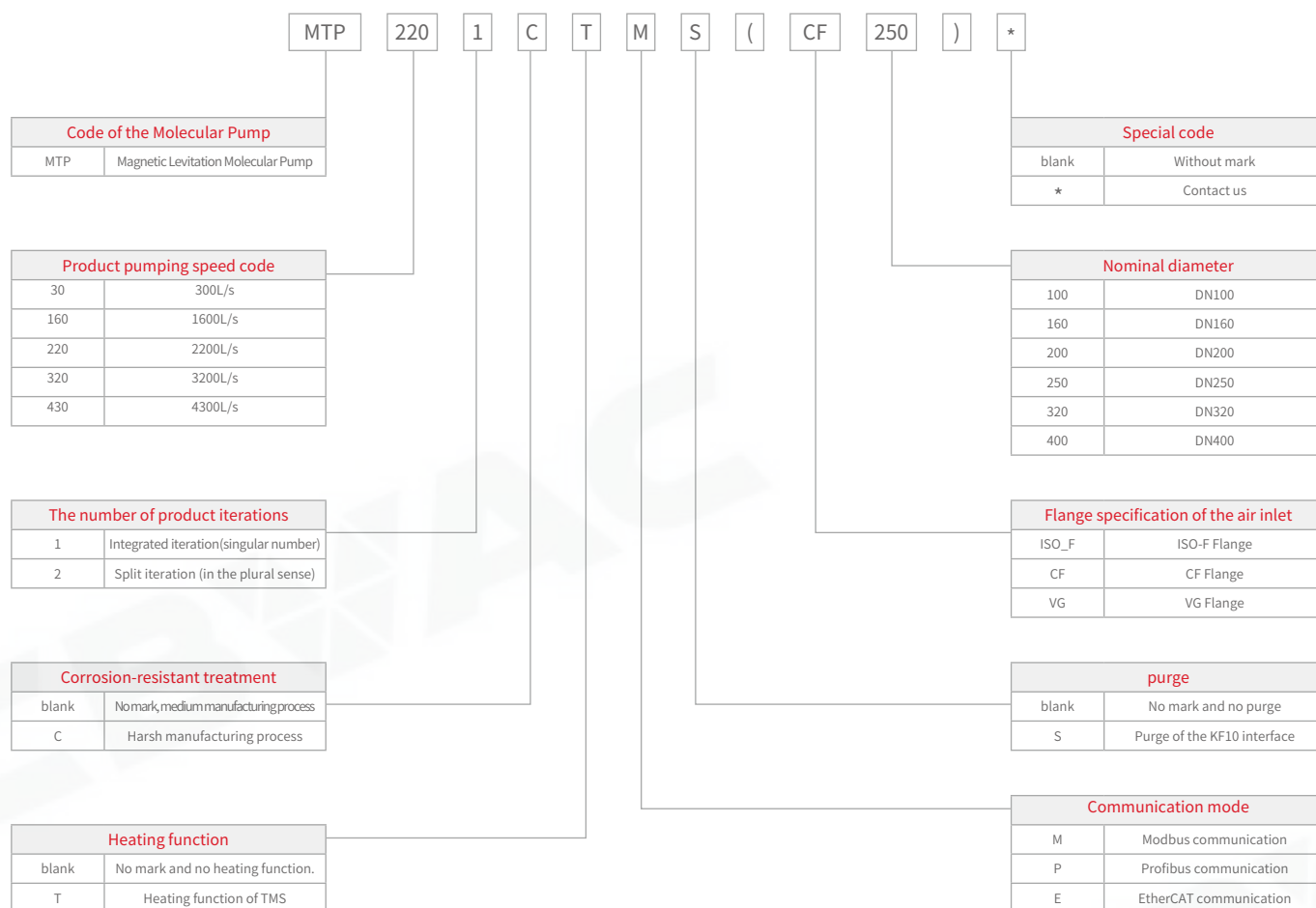
Specific model examples of MTP pumps:

MTP-3201CTMS(ISO320F) indicates: MTP-3201 series magnetic levitation molecular pump, MODBUS communication mode, optional corrosion resistance, TMS heating function, purging function, and equipped with ISO320F flange.

Users can determine the required MTP pump model based on their actual usage needs, according to the MTP function and the following model composition forms.

Note: If the user has other requirements, please contact Zhongke Jiuwei.

The composition and explanation of the product code for MTP pumps are as follows:



※ Compliance standards: CE certification, SEMI-S2/S8/F47 standards

1.2 cell structure

1.2.1 Names and functions of various components

(一) MTP-1601CTMS(ISO200F) Magnetic Suspension Molecular Pump

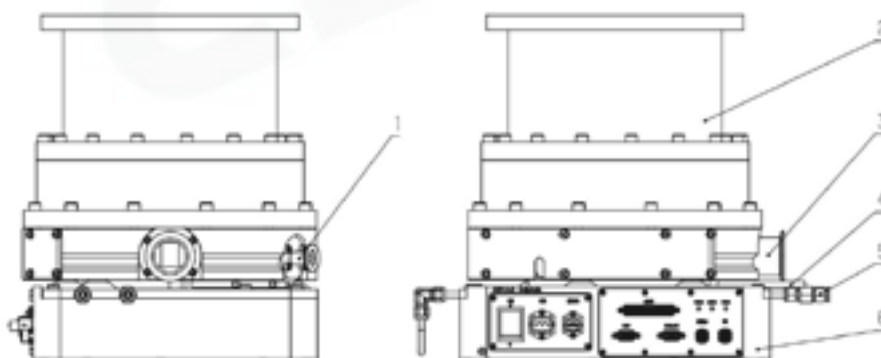


Figure2 Schematic diagram of the structural composition of the pump

1. Purge interface
2. case of pump
3. Front-stage interface
4. Pump body cooling water interface
5. Controller cooling water interface
6. controller

(二) MTP-2201CTMS(ISO250F) Magnetic Suspension Molecular Pump

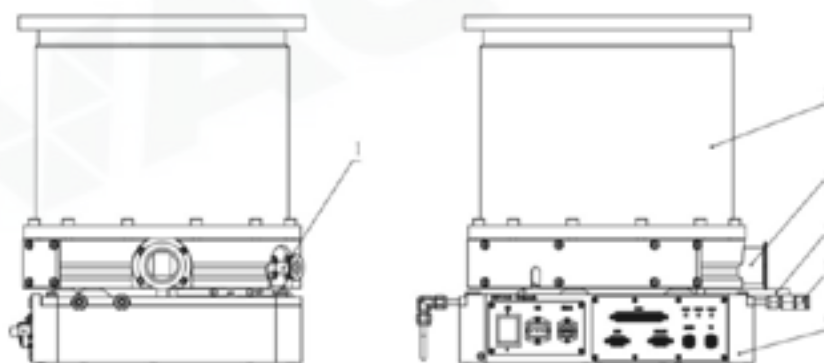


Figure3 Schematic diagram of the structural composition of the pump

1. Purge port
2. case of pump
3. Front-stage interface
4. Pump body cooling water interface
5. Controller cooling water interface
6. controller

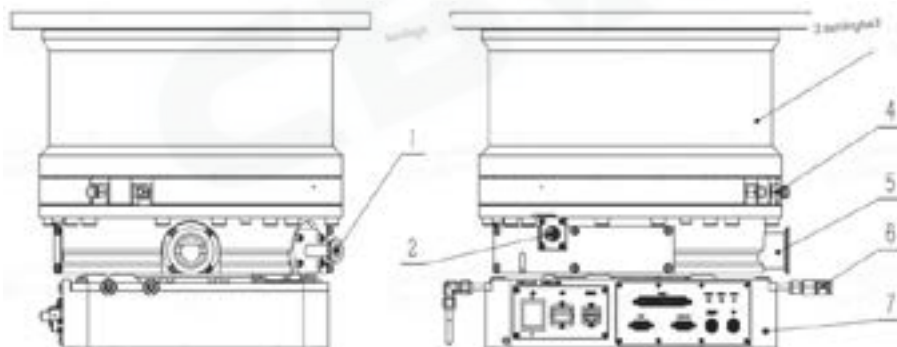
(三) MTP-3201CTMS(ISO320F) Magnetic Suspension Molecular Pump

Figure4 Schematic diagram of the structural composition of the pump

1. Purge interface
2. TMS temperature sensor interface
3. case of pump
4. Pump body cooling water interface
5. Front-stage interface
6. Controller cooling water interface
7. controller

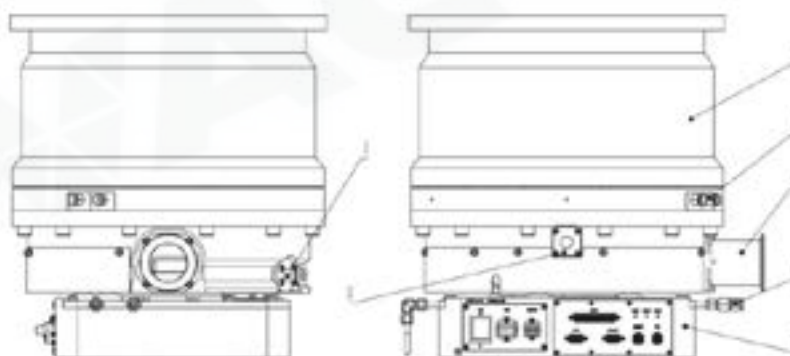
(四) MTP-4301CTMS(ISO320F) Magnetic Suspension Molecular Pump

Figure5 Schematic diagram of the structural composition of the pump

1. Purge interface
2. TMS temperature sensor interface
3. case of pump
4. Pump body cooling water interface
5. Front-stage interface
6. Controller cooling water interface
7. controller

1.2.2 Name and function of the standard controller

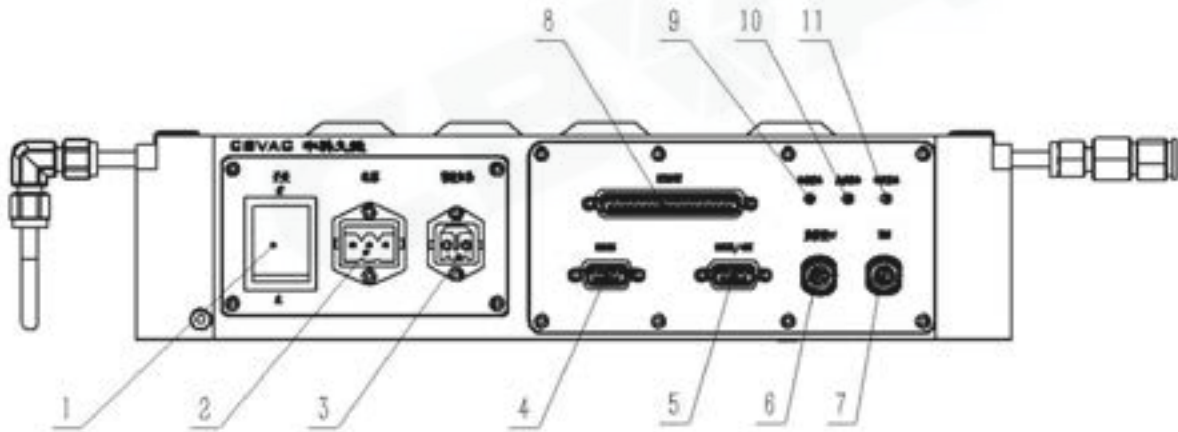


Figure6 Standard Controller (Front Panel)

- | | | |
|---------------------------|---------------------------|--------------------------------------|
| 1. Switch button | 5. RS232/485 port | 9. Power status indicator light |
| 2. Power supply port | 6. Monitoring module port | 10. Fault status indicator light |
| 3. Auxiliary heating port | 7. TMS port | 11. Operating status indicator light |
| 4. RS485 port | 8. REMOTE port | |

Table2 Controller Front Panel Functions

Serial Number	name	function
1	Switch button	Control the power switch for external power supply (it is strictly prohibited to turn off the main power switch when the MTP pump is operating normally).
2	Power supply port	External power supply interface, input voltage range: 220±20%VAC (50/60Hz).
3	Auxiliary heating port	An auxiliary heating unit for connecting to the TMS function (optional).
4	RS485 port	RS485 communication interface (COM2 interface) for connecting to the host computer.
5	RS232/485 port	RS232/485 communication interface (COM1 interface) for connecting to the host computer.
6	Monitoring module port	The monitoring module communication interface (COM3 interface) is used to connect to the monitoring module (optional), which can be used to configure the MTP pump.
7	TMS port	Used for connecting temperature sensors and cooling units with TMS functionality.
8	REMOTE port	Used to implement external I/O port control functions.
9	Power status indicator	When an external power supply is connected, the power status indicator light is constantly green.
10	Fault status indicator light	The current fault or alarm is indicated by the flashing frequency or color of the indicator light. Blinking red: Fault category. Blinking orange: Warning category.
11	Operating status indicator light	The current operating status is indicated by the flashing frequency or color of the indicator light. Green flashing: Acceleration state. Blue flashing: Deceleration state.

1.3 Technical Parameter

1.3.1 Specifications of MTP pump

Table3: MTP Pump Specifications

Serial Number name		MTP-1601 series		MTP-2201 series		MTP-3201 series		MTP-4301 Series	
		Bore size 1	Caliber 2	Caliber 1	Bore diameter 2	Caliber 1	Bore diameter 2	Caliber 1	Caliber 2
Flange size	Inlet flange	ISO160F	ISO200F	ISO200F	ISO250F	ISO250F	ISO320F	ISO320F	ISO400F
	Exhaust port flange	KF40		KF40		KF40		KF40	
Pumping speed (L/s)	N2	1000	1600	/	2200	2650	3200	4000	4300
	Ar	/	/	/	1900	2300	2800	/	/
	H2	800	1200	/	1700	2050	2300	2700	2700
Compression ratio	N2, Ar	>10 ⁸		>10 ⁸		>10 ⁸		>10 ⁸	
	H2	1.0×10 ³		>2.0×10 ³		>1.0×10 ³		1.0×10 ⁴	
Ultimate pressure (Pa)		10 ⁻⁷ (after baking)		10 ⁻⁷ (after baking)		10 ⁻⁷ (after baking)		10 ⁻⁷ (after baking)	
Maximum continuous backing pressure (Pa) (with TMS function enabled)		266		266		266		266	
Purge gas flow rate (N2) (Pa·m ³ /s) (SCCM)		8.4×10 ⁻² ± 1.7×10 ⁻² (50 ±10)		8.4×10 ⁻² ± 1.7×10 ⁻² (50 ±10)		8.4×10 ⁻² ± 1.7×10 ⁻² (50 ±10)		8.4×10 ⁻² ± 1.7×10 ⁻² (50 ±10)	

(Continued)

model	MTP-1601 series		MTP-2201 series		MTP-3201 series		MTP-4301 series	
	Caliber 1	Caliber 2	Bore size 1	Caliber 2	Caliber 1	Diameter 2	Caliber 1	Diameter 2
Rated speed (rpm)	36540		27000	27720	24240	ISO320F	ISO320F	ISO400F
Temperature control system (TMS)	support		support		support		support	
Pump housing baking temperature (°C)	< 120		< 120		< 120		< 120	
Rotor drop-off speed (during abnormal power loss of external power supply) (rpm)	About 8000		Approximately 5000		About 5000		About 5000	
Start-up time (min)	≤ 8		≤ 8		≤ 10		≤ 11	
Shutdown time (min)	≤ 9		≤ 11		≤ 16		≤ 19	
Noise (dB)	< 55 (36540rpm)		< 55 (27000rpm)		< 55 (27720rpm)		< 55 (24240rpm)	
lubricant	NOT REQUIRED		NOT REQUIRED		NOT REQUIRED		NOT REQUIRED	
installation angle	arbitrary		arbitrary		arbitrary		arbitrary	
Cooling method	water-cooling		water-cooling		water-cooling		water-cooling	
Front-stage pumping speed (L/min)	> 1300		> 1300		> 1300		> 1300	
Weight (kg)	45	48	58	60	79	84	111	
IP degree	IP54		IP54		IP54		IP54	
Operating ambient temperature (°C)	0 ~ 40		0 ~ 40		0 ~ 40		0 ~ 40	
Storage temperature (°C)	-25 ~ 55		-25 ~ 55		-25 ~ 55		-25 ~ 55	

1.3.2 Maximum gas flow rate

Table:4 Maximum gas flow rate (without TMS function)

cooling water	Backing Pump	Gas category	MTP-1601 series		MTP-2201 series		MTP-3201 Series		MTP-4301 Series	
			Maximum gas flow rate		Maximum gas flow rate		Maximum gas flow rate		Maximum gas flow rate	
			Pa·m ³ /s	SCCM	Pa·m ³ /s	SCCM	Pa·m ³ /s	SCCM	Pa·m ³ /s	SCCM
15 ~ 25°C	> 1300L/min	Ar	1.52	900	3.21	1900	2.87	1700	3.21	1900
		N2	4.05	2400	3.72	2200	4.05	2400	3.72	2200
	> 10000L/min	Ar	1.69	1000	4.39	2600	3.55	2100	4.39	2600
		N2	7.94	4700	7.26	4300	6.76	4000	7.26	4300
25 ~ 35°C	> 1300L/min	Ar	1.18	700	2.36	1400	2.53	1500	2.7	1600
		N2	4.05	2400	3.72	2200	3.72	2200	3.38	2000
	> 10000L/min	Ar	1.35	800	2.36	1400	2.87	1700	3.55	2100
		N2	7.94	4700	5.07	3000	6.59	3900	6.08	3600

Table:5 Maximum gas flow rate (with TMS function, and TMS heating temperature at 70°C)

cooling water	Backing Pump	Gas category	MTP-1601 series		MTP-2201 series		MTP-3201 Series		MTP-4301 Series	
			Maximum gas flow rate		Maximum gas flow rate		Maximum gas flow rate		Maximum gas flow rate	
				SCCM	Pa·m ³ /s	SCCM	Pa·m ³ /s	SCCM	Pa·m ³ /s	SCCM
15 ~ 25°C	> 1300L/min	Ar	2.7	1600	1.18	700	2.03	1200	2.2	1300
		N2	4.05	2400	2.7	1600	3.55	2100	2.87	1700
	> 10000L/min	Ar	3.04	1800	1.18	700	2.03	1200	2.53	1500
		N2	7.94	4700	3.04	1800	5.07	3000	4.73	2800
25 ~ 35°C	> 1300L/min	Ar	2.19	1300	/	/	/	/	/	/
		N2	4.05	2400	/	/	/	/	/	/
	> 10000L/min	Ar	2.53	1500	/	/	/	/	/	/
		N2	7.94	4700	/	/	/	/	/	/

The maximum gas flow rate is applicable to continuous vacuum pumping of nitrogen or argon under the condition of using purge gas, with nitrogen at $8.4 \times 10^{-2} \pm 1.7 \times 10^{-2}$ Pa·m³/s (50 ± 10 SCCM). For example, when gas is discharged intermittently, it is possible to discharge gas exceeding the maximum flow rate.

1.3.3 controller

Note: It is strictly prohibited to conduct an insulation test on the controller! When conducting an insulation test on the pump body, please disconnect the controller from the pump body.

Table:6 Controller functional parameters (differential parts of MTP pumps)

Pump model	Maximum input power (VA)	Output frequency (Hz)
MTP-1601 series (without TMS)	750	<609
MTP-1601T series (with TMS)	1050	
MTP-2201 series (without TMS)	1200	<450
MTP-2201T series (with TMS)	1500	
MTP-3201 series (without TMS)	1500	<462
MTP-3201T series (with TMS)	1800	
MTP-4301 series (without TMS)	1700	<404
MTP-4301T series (with TMS)	2200	

Table:7 Controller functional parameters (common parts of MTP pumps)

Performance parameters		MTP pump
Input voltage range (VAC)		Single-phase 220±20%
Input frequency (Hz)		50/60
Maximum leakage current (mA)		2.0
Fuse specification (A)		10
Fuse current surge withstand capability (A)		100 (260VAC 50/60Hz)
pollution degree		2
Overvoltage level		II
Motor drive system		Permanent magnet synchronous motor
LED	Power indicator	green
	Fault indication	Red/Orange
	RUN	Green/Blue
	Data indication	green
	Communication interruption indication	orange
	Error indication	red
Input/output port	Power input port	3-pin
	Auxiliary heating port	2-pin
	REMOTE port	37-pin
	RS232/485 port	9-pin
	RS485 port	9-pin
	Monitoring module port	8-pin
	TMS port	5-pin
Detection function		Abnormal detection of magnetic bearings
		Overheat detection of MTP pump
		Motor overload detection
		Power supply anomaly detection
		Overspeed detection of MTP pump
		Controller overheat detection
		Other abnormality detection

1.3.4 Inlet fixing bolt

Table8 Bolt Dimensions

Pump model	MTP-1601 series		MTP-2201 series		MTP-3201 Series		MTP-4301 Series	
flange type	ISO160F	ISO200F	ISO200F	ISO250F	ISO250F	ISO320F	ISO320F	ISO400F
Bolt specification	M10	M10	M10	M10	M10	M12	M12	M12

1.3.5 bake

Baking the MTP pump can achieve lower pressure in a short period of time, thereby reducing the exhaust time. Cooling must be performed simultaneously during baking. Please ensure that the cooling pipeline is working properly before starting the baking process, and the temperature set during baking must not exceed 120 °C to prevent the MTP pump from triggering overheat protection and shutting down.

1.3.6 corrosion preventive

The corresponding operations must be performed by personnel skilled in the installation, operation, and maintenance of MTP pumps, and it is imperative to carefully read this manual before operation.

Note:

(一) Corrosion-resistant MTP pumps can be used in applications involving chlorine or fluorine gas

(二) When containing the following gases, please contact Zhongke Jiuwei for confirmation

1. Alkali metals (excluding lithium gas)
2. Ga, Hg, In, or Sn
3. HBr

1.4 Overall dimensions

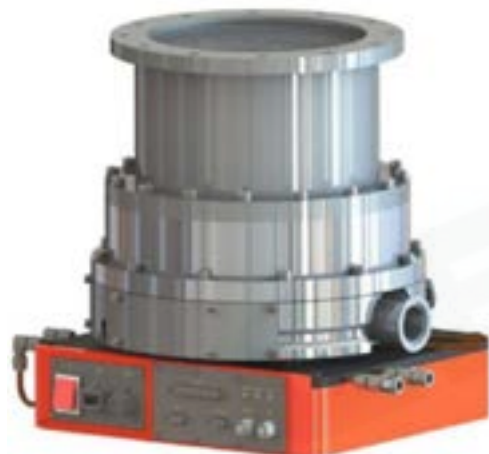
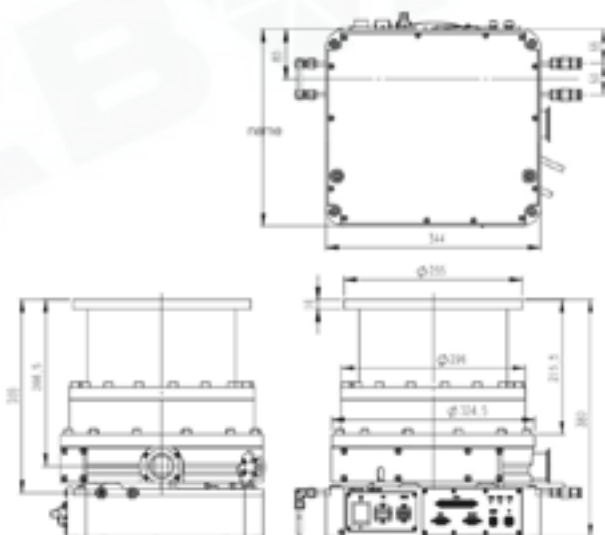


Figure9 Outline drawing of MTP-2201CTMS(ISO250F)

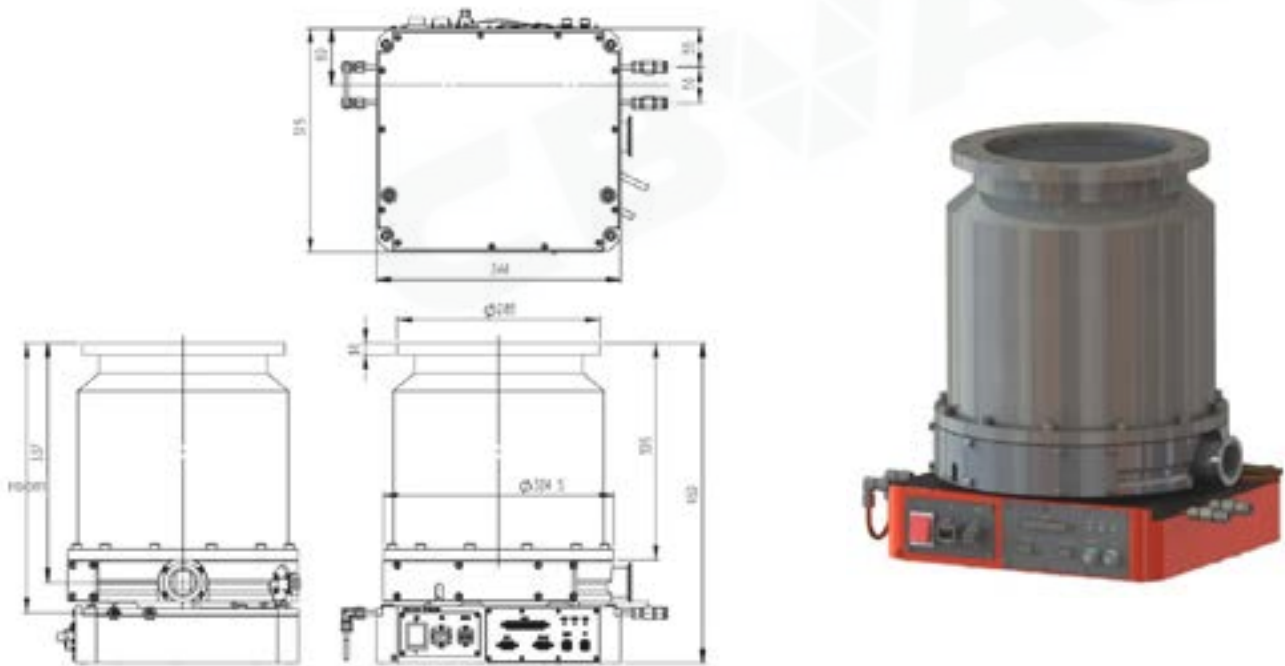


Figure7 MTP-1601CTMS(ISO200F) Outline Drawing

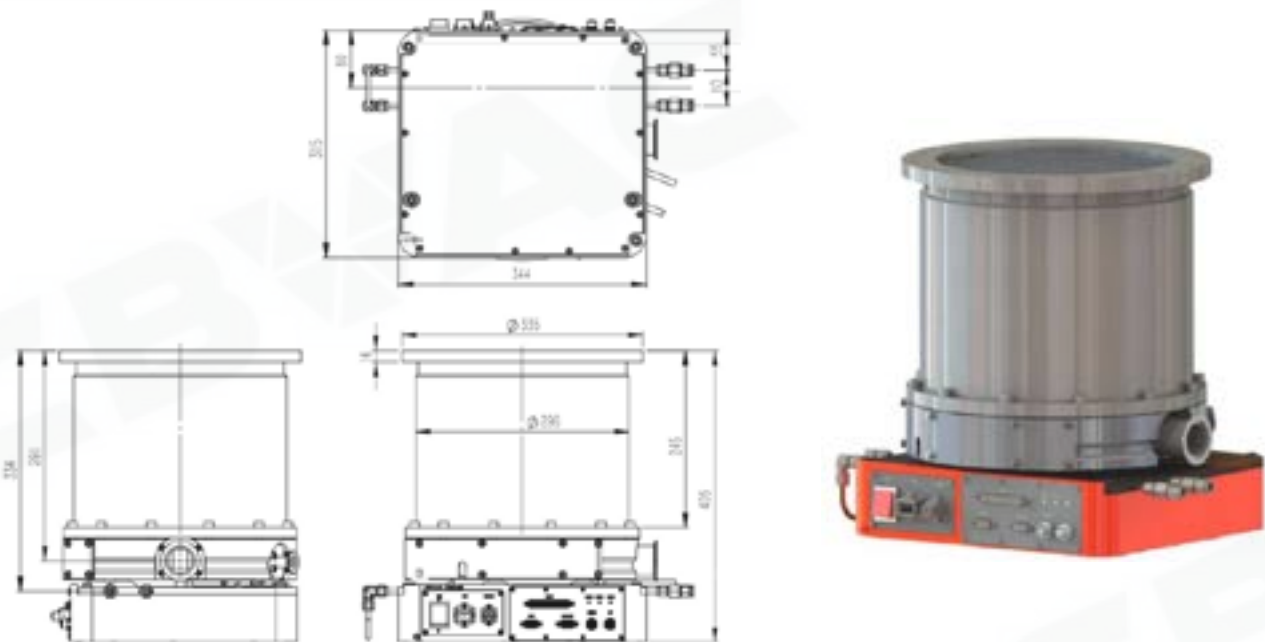


Figure7 MTP-1601CTMS(ISO200F) Outline Drawing

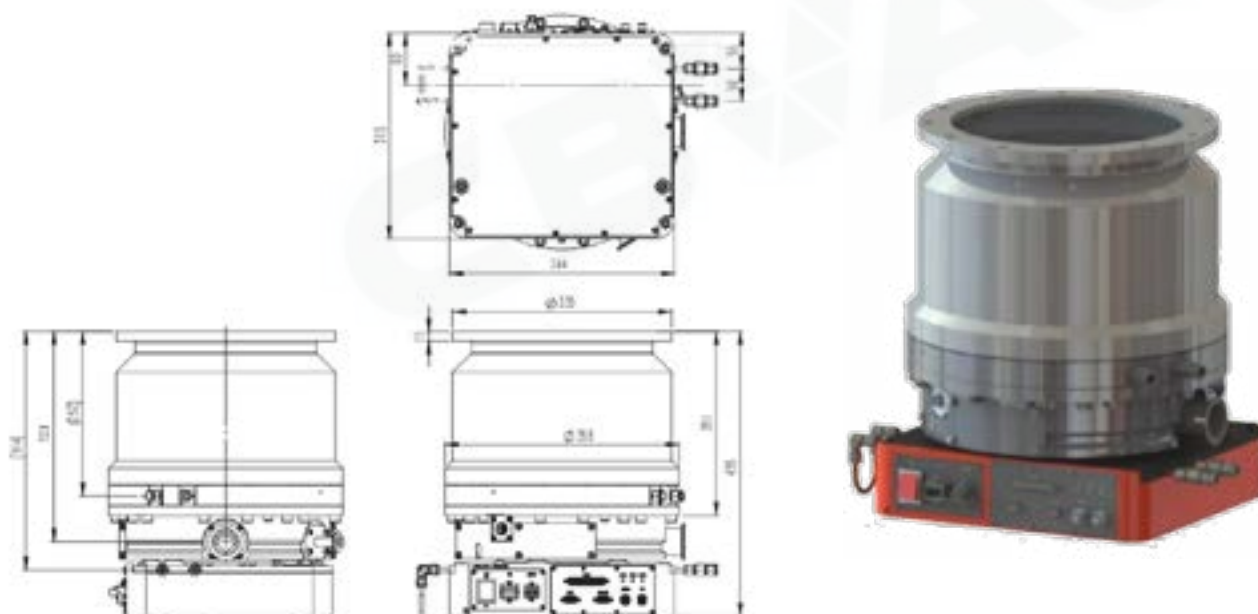


Figure10 MTP-3201CTMS(ISO250F) Outline Drawing

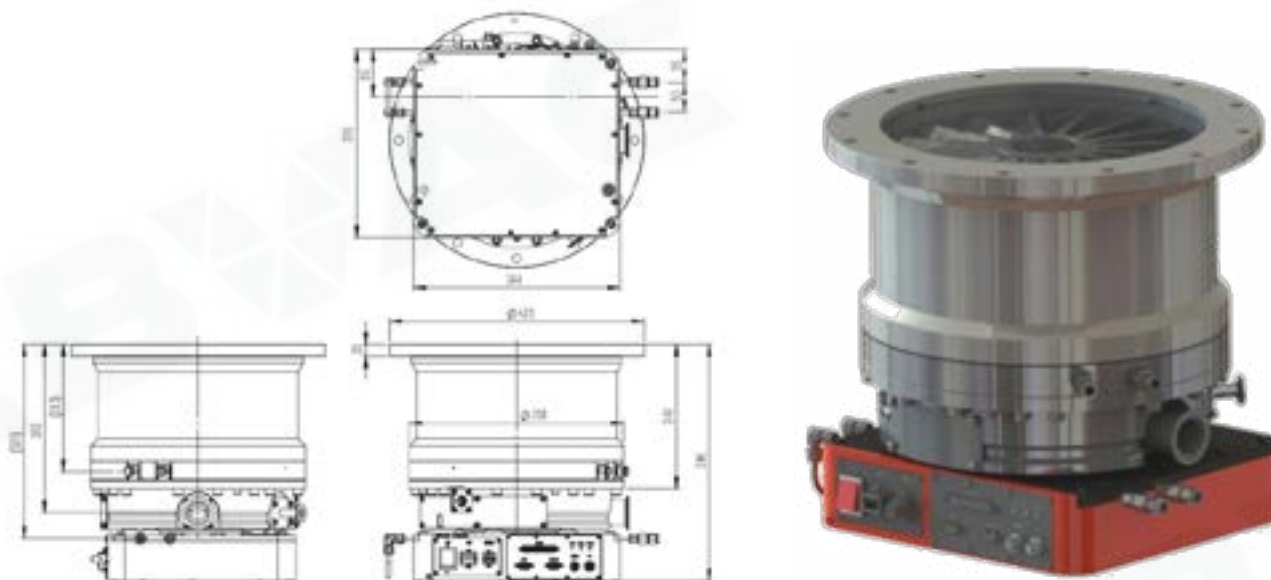


Figure11 MTP-3201CTMS(ISO320F) Outline Drawing

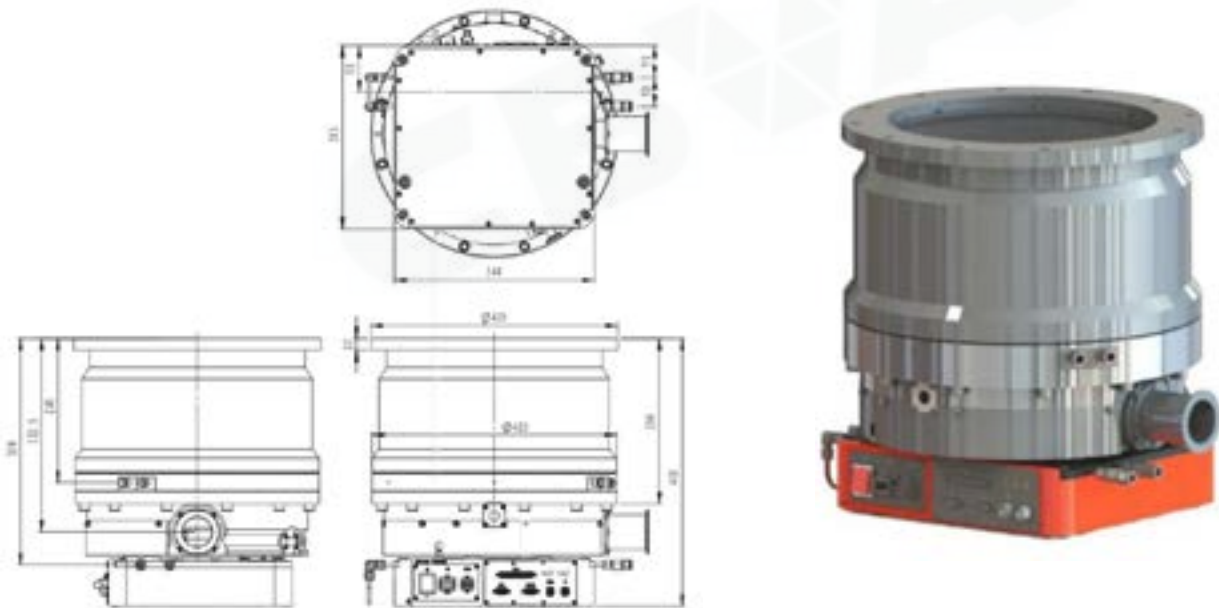


Figure12 MTP-4301CTMS(ISO320F) Outline Drawing

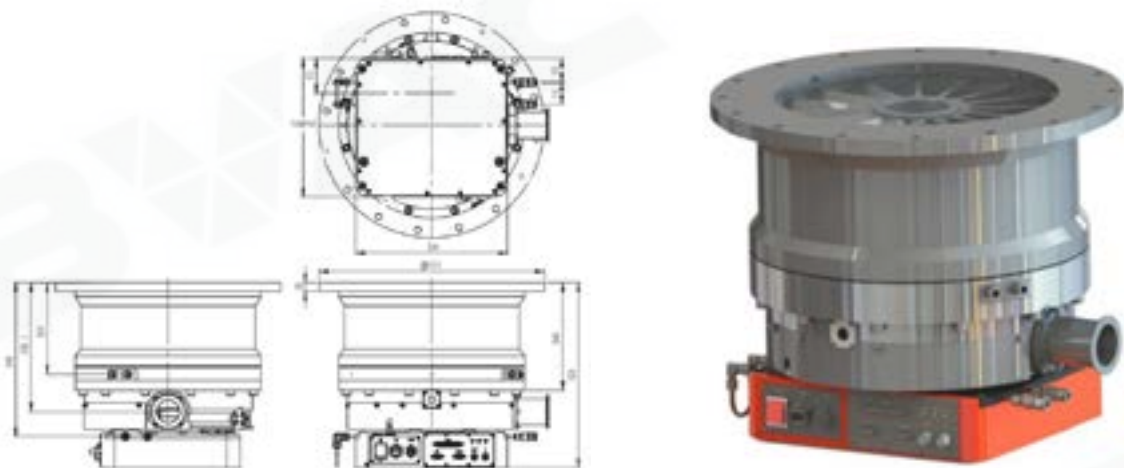


Figure13 MTP-4301CTMS(ISO400F) Outline Drawing

1.5 check and accept

(一) Please check if the casing is damaged.

(二) It is recommended to retain the packaging materials for future reuse. If you find any damage to the outer packaging of the MTP pump or any signs of impact damage to the box, please do not sign for it and contact our company immediately.

(三) Check whether the accompanying list is consistent with the purchase order, and count the spare parts inside the box according to the accompanying list. If any inconsistency is found, please contact our company in a timely manner.

(四) The MTP pump has a relatively heavy weight, so please use a lifting device or other appropriate methods to hoist the MTP pump.

1. The lifting point is located at the flange interface hole of the air inlet. During the lifting operation, please avoid scratching the air inlet flange of the MTP pump. When the lifting point is located at the bottom of the controller, the four lifting holes on the outside of the controller should be used.

(1) The lifting equipment must comply with national standards. The crane and lifting eyebolt must be capable of withstanding a weight five times or more the self-weight of the MTP pump, and the lifting sling must be capable of withstanding a weight seven times or more the self-weight of the MTP pump.

(2) When lifting the MTP pump, it should be kept stable to prevent shaking or falling.

(3) When lifting, please use at least two lifting belts.



Figure14 Lifting diagram (vertical)

2. When installing the MTP pump horizontally using lifting equipment, it is necessary to secure lifting points at locations such as the pump casing and pump base. Do not place the lifting points at protruding positions of the MTP pump, such as the exhaust port and purge port, to prevent damage.



Figure15 Lifting schematic diagram (horizontal) (taking MTP-3201CTMS(ISO250F) as an example)

3. When the MTP pump is placed upright and lifted from the bottom, it must be positioned on a flat surface that is larger than the dimensions of the controller's bottom to prevent damage to the controller.

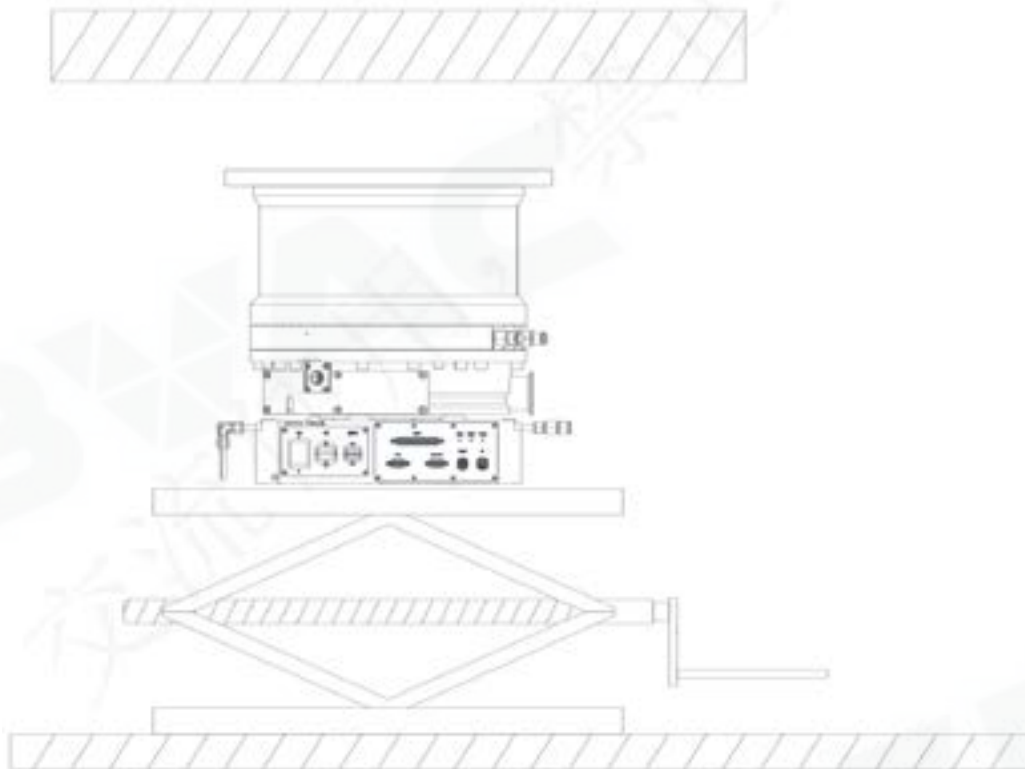


Figure16 Hoisting schematic diagram (lifting) (taking MTP-3201CTMS(ISO320F) as an example)

1.6 install

1.6.1 clean

(一) Before installation, please inspect the sealing areas of the inlet and outlet flanges for any contamination such as dust or oil. These can be cleaned using purified gas purging or wiped with a solvent (such as alcohol).

(二) Before installation, please inspect the outer surface of the flange seal for any scratches or abrasions, and during the installation process, please avoid damaging the flange. If any scratches or abrasions are found, please contact our company promptly.

(三) Please note during installation that the protective net cannot completely prevent foreign objects from falling into the MTP pump, so be extremely careful during installation.

(四) It is recommended to install it in a clean environment.

1.6.2 Installation environment

The MTP pump should be installed in an area that meets the following requirements:

Table9 Environmental requirements for installation

ambient temperature	0 ~ 40℃
Ambient relative humidity	30% to 95% (non-condensing)
Environmental requirements	No external mechanical impact; Keep away from heat sources; In the area without a strong magnetic field (the axial direction corresponding to the rotation axis is 15 mT, and the radial direction is 3 mT); No strong electric field; No radiation; No high-voltage discharge (500V and above); Other precautions: Avoid placing or installing the magnetic suspension molecular pump in areas exposed to direct sunlight, high temperature and humidity, dust, dripping water, flammable and explosive atmospheres, corrosive gases, high-frequency vibrations, and noise interference.
Installation conditions for MTP pump	A protective net must be installed to prevent foreign objects from falling into the pump! The inlet flange must be kept away from heat sources!

1.6.3 installation area

A sufficient space should be reserved at the front end of the controller for installing wiring harnesses and cables. To avoid damage caused by excessive bending of wiring harnesses and cables, the turning radius of the cables must not be less than 150mm.

1.6.4 installation direction

The MTP pump supports installation at any angle.

Note: To reduce the load on the magnetic bearings of the MTP pump, when installing it horizontally or at an angle, please place the front port of the MTP pump on a vertical or horizontal plane.

1.6.5 External power supply

The standard power cable length is 3 meters (please contact ZKJW for other sizes). Please connect the power cable to a main power supply with independent switch and protection functions, ensure that the protection device and main power supply have sufficient capacity, and maintain good grounding.

1.6.6 vacuum line

To protect the MTP pump, please install a vacuum valve between the foreline port and the backing pump. When the backing pump is stopped, make sure to keep the vacuum valve closed. To further optimize the performance of the MTP pump, the following measures are recommended:

(一) Please inspect the surface for any scratches before installation, and avoid scratching the MTP pump and the flange of the vacuum equipment during installation and use.

(二) Please make every effort to improve the leakage situation of the equipment connected to the MTP pump and perform degassing treatment on the pipeline.

(三) Please select a pre-pump with a suitable capacity. When using an oil-lubricated pre-pump, please install a vacuum valve between the MTP pump and the pre-pump, and also equip it with an adsorption trap to avoid oil vapor contaminating the interior of the MTP pump and causing malfunction.

Connection method of vacuum pipeline:

(一) Connect the inlet end of the MTP pump to the high vacuum side.

(二) Connect the outlet end of the MTP pump to the inlet end flange of the backing pump.

1.7 Water cooling

When the following situations occur, water cooling must be applied to the MTP pump:

(一) Extract high-temperature gas;

(二) Perform baking and heating;

(三) Utilize the TMS function.

The precautions for water cooling are as follows:

(一) Ensure that the pipeline is well sealed to prevent water leakage;

(二) It is recommended to use purified water as cooling water to prevent blockage or corrosion of the pipeline;

(三) When planning to disuse the MTP pump for an extended period or relocate it, please use compressed air to clear the residual cooling water from the pipeline;

(四) Water shortage or abnormal cooling may trigger the protective function of the MTP pump, resulting in shutdown;

(五) The inlet and outlet are made of stainless steel. To avoid corrosion, please use stainless steel connectors.

1.7.1 Service conditions of cooling water

Table 1:10 Operating Conditions for Cooling Water

project	specifications
port type	PC10 (straight-through quick-connect)
Flow rate (L/min)	3
Water temperature (°C)	15 ~ 35
Resistivity (kΩ · cm)	4 to 1000
ph value	6.5~8.0
Water pressure (MPa)	0.3
Turbidity (FNU)	< 30

1.7.2 Connection method of water-cooled tube

Please strictly follow the requirements in the previous chapter to select cooling water and cooling devices, and ensure that the cooling water circulation pipeline is free from any issues such as "leakage, overflow, dripping, or seepage". It is recommended to install a leakage detection device to ensure the safety of the cooling water circulation and cooling devices. The MTP pump is divided into pump body cooling and controller cooling, which should be connected separately.

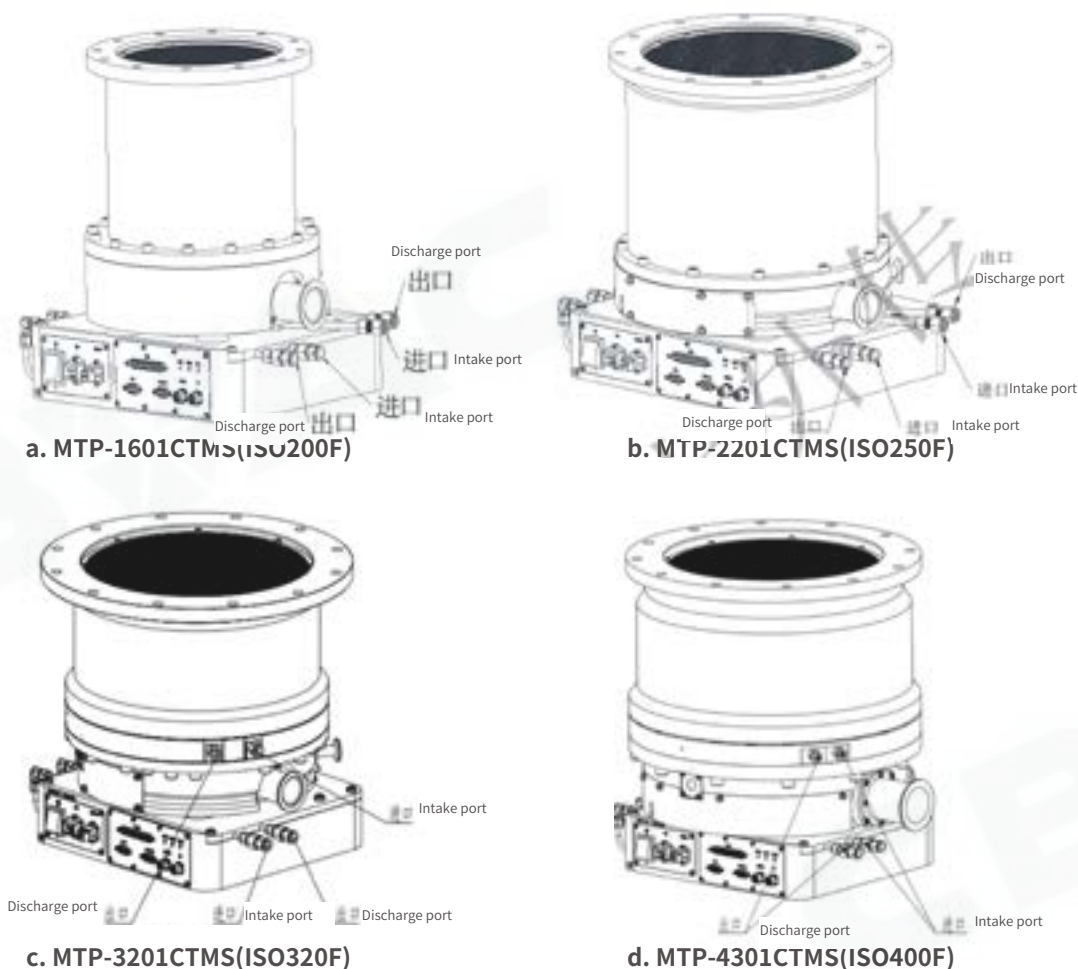


Figure:17 Position of cooling water inlet

1.8 TMS (Temperature Management System) function (optional)

The TMS function comprises the following units:

(一) Detection unit: used for detecting the temperature of the pump body.

(二) Cooling unit: Used to control the on/off of cooling water for the pump body. The valve used is a 24VDC controlled, normally closed water-cooled valve, and a two-way or three-way water-cooled valve can be selected according to customer needs.

(三) Heating unit: used for heating the MTP pump.

The TMS function (Temperature Management System) heats the entire pump body by heating the base of the MTP pump. A detection unit placed on the base continuously monitors the temperature of the pump body. The temperature signals collected by the detection unit are transmitted back to the MTP pump controller, which maintains a constant temperature of the pump body by controlling the valve opening of the TMS cooling unit and the on/off status of the heating unit. Note: The TMS function of the MTP pump must be used in conjunction with water cooling.

1.8.1 Technical parameters of TMS function

Table11 Technical parameters of TMS function

project	specifications	unit
Temperature control strategy	Intermittent control of heating unit, cooling water flow control	-
Temperature control value	40 to 70 (default is 70)	°C
Control accuracy	±2	°C
Fault Alarm	Equipped with (outputting a fault alarm signal by the MTP pump controller)	-
rated operational voltage	220	VAC (50/60Hz)
rated power	MTP-2201 and MTP-3201: 300	
MTP-4301: 500	VA	
Cooling unit solenoid valve control voltage	24	VDC

1.8.2 Electrical connection of TMS function

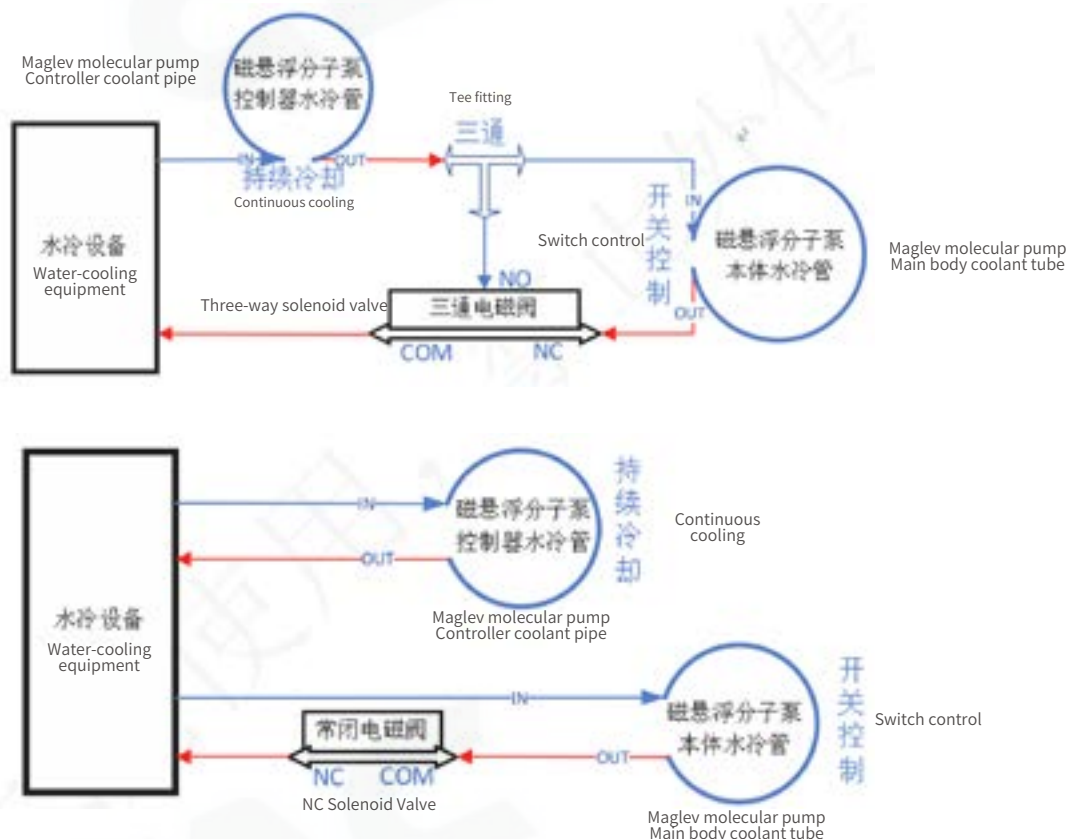
When configuring the TMS function, it is necessary to connect the electrical wiring. To avoid misconnection, all connection terminals are designed differently. A summary is as follows:

(一) "TMS" port connecting cable. This cable harness is an accessory shipped with the pump. One end of the connecting cable is connected to the "TMS" port on the front panel of the controller, and the other end is connected to the water cooling valve. The standard length of this part is 1 meter (for other sizes, please contact Zhongke Jiuwei). For the MTP-3201 series and MTP-4301 series magnetic levitation molecular pumps, there is still a third port interface connected to the temperature sensor interface of the pump body.

(二) Heating unit wiring harness. This wiring harness is installed on the MTP pump and is connected to the "auxiliary heating" port on the front panel. To ensure safety during TMS operation, a fuse is built into the wiring harness of the TMS heating unit.

1.8.3 Cooling unit connection for TMS function

The TMS function must be used in conjunction with water cooling. The connection method of the water cooling tube is described in Section [insert appropriate section number]0. Figure 18 Several recommended connection methods for the cooling unit are listed. For units that include a normally closed solenoid valve (b), two water circuits are required for constant temperature control.



b. Normally closed solenoid valve

Figure18 TMS cooling unit connection

Note: When using a normally closed solenoid valve for cooling, the cooling water circulation device must also be stopped simultaneously with the closing of the normally closed solenoid valve.

Note: The standard solenoid valve is a three-way solenoid valve with a valve interface size of Rc 1/4. If you need to choose another solenoid valve, please contact Zhongke Jiuwei.

1.9 Purging function (optional)

When filling the MTP pump with reactive or corrosive gases (including hydrogen), please simultaneously introduce dry N₂ or other protective gases into the MTP pump through the purge port to prevent damage to the interior of the MTP pump.

Note:

When the purge function is not in use, please seal the purge port with a blind plate.

The purge port standardly equipped on MTP is a KF10 interface. If other sizes of purge ports are required, please contact Zhongke Jiuwei.

The purge port position of the MTP (Magnetic Suspension Molecular Pump) is shown in Figure 191:

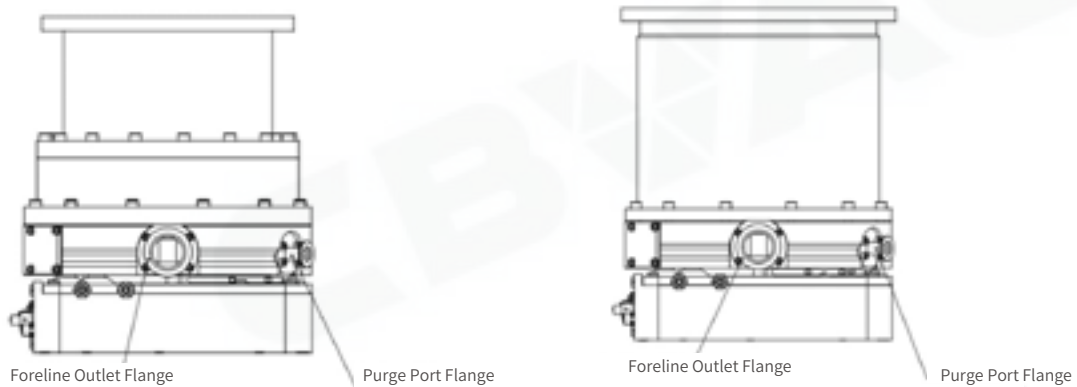


Figure:19 Connection of purge port (taking MTP-1601CTMS(ISO200F) as an example) Figure:20 Connection of purge port (taking MTP-2201CTMS(ISO250F) as an example)

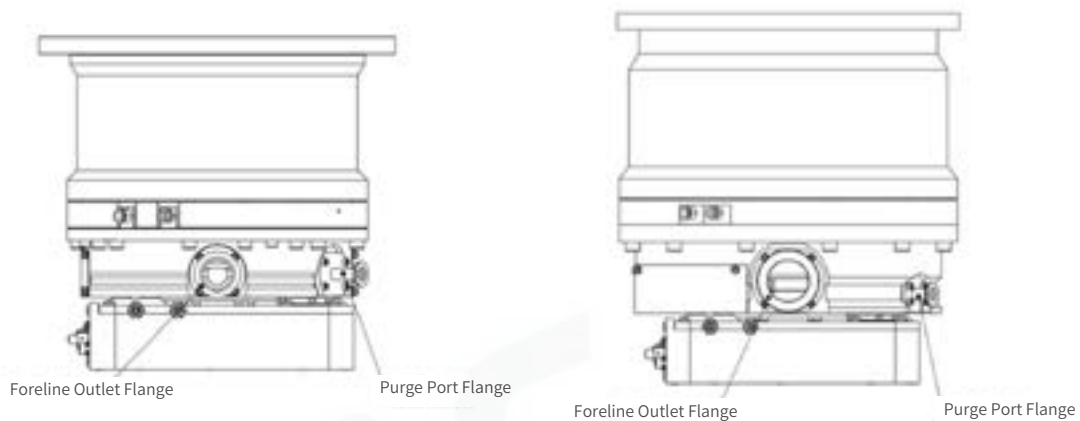


Figure21 Connection of purge port (taking MTP-3201CTMS(ISO320F) as an example) Figure22 Connection of purge port (taking MTP-4301CTMS(ISO320F) as an example)

1.10 Precautions for semiconductor applications

When applying MTP pumps to semiconductor equipment, please pay attention to the following aspects.

1. Power Supply: The power distribution system should be integrated with other semiconductor equipment and equipped with a separate circuit breaker with a rated current of at least 10A, which can withstand an instantaneous surge of at least 10kArms current.
2. Emergency stop circuit (EMO): The EMO function can be achieved by directly powering off the MTP pump. At this time, the MTP pump will trigger the external power supply abnormal power-down protection, and the rotor will fall onto the protective bearing, achieving a free stop through friction with the protective bearing.

To ensure personal safety, the triggering device of the EMO should be placed away from the area where the MTP pump may pose a hazard during operation.

2 Operating Instructions

2.1 start

2.1.1 Confirmation items

Before starting, please make sure to confirm the following items again:

- (一) Ensure that the installation of the MTP pump meets the requirements;
- (二) Ensure that the external power supply meets the requirements;
- (三) Ensure that all cables are properly connected and securely fastened;
- (四) Ensure that the vacuum pipeline has undergone leak rate testing.

2.1.2 Backing Pump

- (一) Start the backing pump

Please start the backing pump before starting the MTP pump. After the backing pump is started, open the vacuum valve located on the outlet flange side.

Note: Do not open the vacuum valve in advance to prevent oil and gas contamination from the preceding pump from flowing back and contaminating the interior of the MTP pump.

Note: Do not frequently start and stop the MTP pump to avoid triggering overheat protection.

- (二) Shut down the backing pump

Before stopping the MTP pump, please first close the vacuum valve located on the outlet flange side, and then close the backing pump.

Note: It is prohibited to shut down the backing pump when the vacuum valve is not closed, to prevent oil and gas contamination from the backing pump from flowing back and contaminating the interior of the MTP pump.

2.1.3 power on

Press the "On/Off" button on the control panel, and the button will light up in red. If there is no fault, the magnetic suspension bearing will automatically operate and be in a suspended state. The "Power Status Indicator" on the front panel will display in green, while the "Fault Status Indicator" and "Operating Status Indicator" will be off. At this time, the MTP pump is in standby mode.

2.2 operate

2.2.1 operating mode

The MTP pump is equipped with a REMOTE interface, RS232/485 interface, RS485 interface, and a monitoring module (optional), all of which can be used to operate the MTP pump. However, only one interface can serve as the control port at a time (the default factory setting is the RS485 interface) for functions such as start-stop control.

2.2.2 Start/Stop

The REMOTE port offers multiple methods to achieve the start-stop function of the MTP pump, and any one of them can be selected for use.

- (一) passive mode

Keep pins 19 and 37 of the REMOTE port open-circuited, and the MTP pump is configured in a passive start-stop control mode at this time.

method	start	stop
1	Keep pin 1 and pin 21 short-circuited, then short-circuit pin 3 and pin 21 and maintain the short-circuit for more than 0.3 seconds. Note: If you first short-circuit pins 3 and 21 before powering on the MTP pump, you must keep pins 3 and 21 short-circuited for more than 10 seconds.	Disconnect the connection between pin 1 and pin 21
2	Short circuit pin 1 and pin 3	Disconnect the connection between pin 1 and pin 3

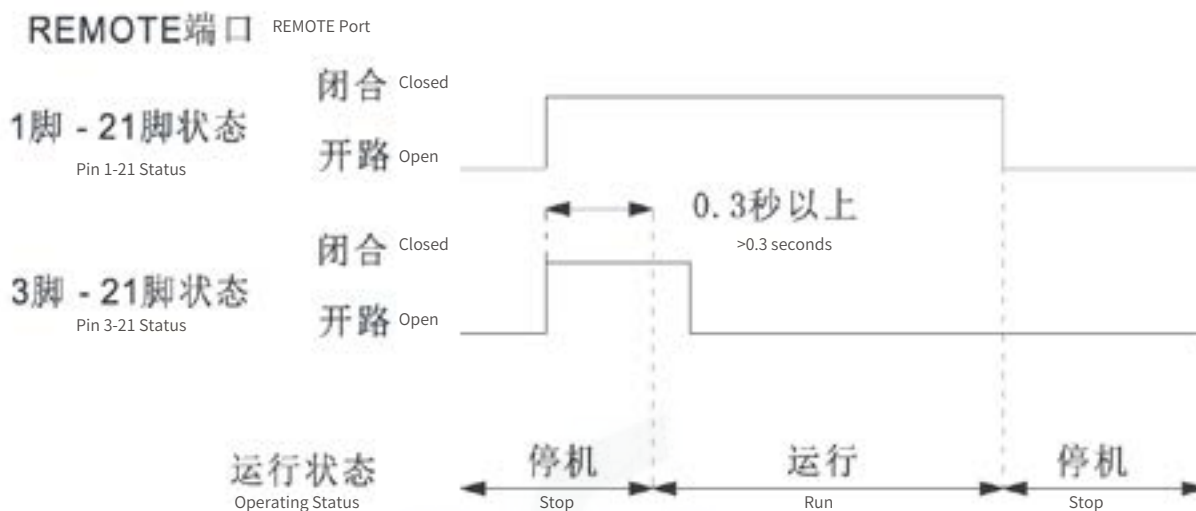


Figure23 Passive start-stop operation mode 1

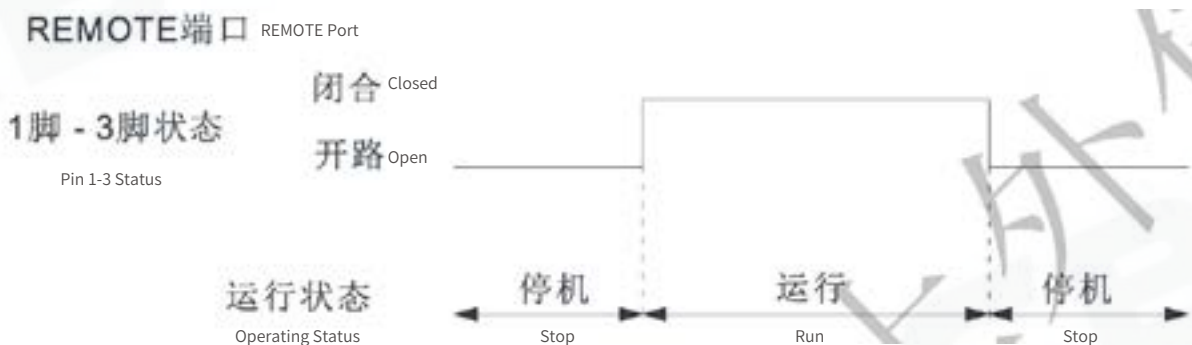


Figure24 Passive start-stop operation mode 2

(二) active mode

Keep pins 19 and 37 of the REMOTE port shorted, and configure the MTP pump to active start-stop control mode.

method	start	stop
1	1. Supply 12~24VDC to pins 21 and 1. 2. Supply 12~24VDC to pins 3 and 1 for a duration of at least 0.3 seconds. Note: Pin 1 is used as the reference ground for the 12~24VDC power supply. Note: When the signal is inputted when the power switch of the pump is not closed, the voltage between pin 3 and pin 1 will persist for at least 10 seconds or longer.	Disconnect the power supply between pin 21 and pin 1.
2	Supply 12~24VDC to pin 3 and pin 1. Note: Pin 1 is used as the reference ground for the 12~24VDC power supply.	Disconnect the power supply between pin 3 and pin 1.

REMOTE端口 REMOTE Port

21脚 - 1脚状态

Pin 21 -1 Status

3脚 - 1脚状态

Pin 3 -1 Status

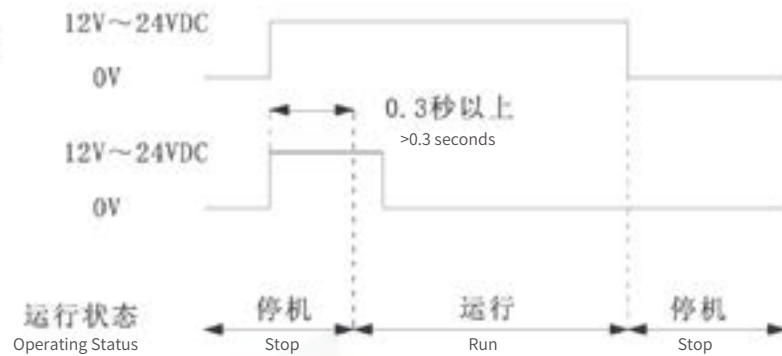


Figure25 Active start-stop operation mode 1

REMOTE端口 REMOTE Port

3脚 - 1脚状态

Pin 3 -1 Status

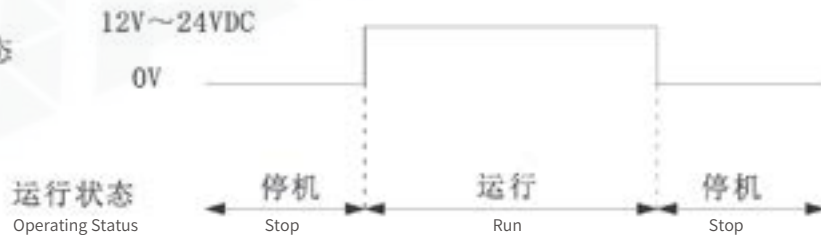


Figure26 Active start-stop operation mode 2

2.3 Shutdown and restart

2.3.1 Restart during shutdown process

During the shutdown and deceleration process, the MTP pump can still perform re-acceleration without having to wait for a complete shutdown.

2.3.2 Restart after protection

is time, it is necessary to conduct troubleshooting and confirm that the "Operation Indicator Light" is no longer flashing. Please perform the fault reset operation according to the following table before restarting the MTP pump.

(一) Passive control. Short-circuit pins 1 and 22 for at least 0.3 seconds.

(二) Active control. Connect pin 1 to the power supply ground, connect pin 22 to the power supply positive terminal, set the power supply voltage to 12~24VDC, and ensure the power supply duration is not less than 0.3 seconds.

2.3.3 shutdown

Please wait for the rotor to completely stop rotating after executing the "shutdown" command, and only then cut off the power supply to the MTP pump once the "Operating Status" indicator light has turned off. The MTP pump completes the shutdown operation when the "Power Status" indicator light is off and the magnetic bearing ceases to be levitated.

2.4 LED

The front panel displays the current status of the MTP pump through three LED indicators: "Power Status", "Operating Status", and "Fault Status".

Table14 Status Indication

LED	Power on state	Acceleration state	Deceleration state	Alarm/fault status
	(Suspended state)			
Power status (Green)	Green constant light	Green constant light	Green constant light	Green constant light (It goes out during a power outage)
Operating state (Green (acceleration and uniform speed process) / Blue (deceleration process))	Extinguish	Illuminated state	rotational speed	It does not affect this indicator light
		Blinking once	Below 2000 rpm	
		Blinking twice	2000rpm to 10000rpm	
		Blinking three times	10,000 rpm to 20,000 rpm	
		Continuous flashing	20000rpm to 90% of rated speed	
		Light	Rated speed * 90% to rated speed	
fault conditions (Orange/Red)	Alarm status: Orange indicator light flashing (The flashing pattern of the LED is used to indicate the type of alarm. See 6.2Section) Fault status: The red indicator light flashes or is constantly on (The flashing pattern of the LED is used to indicate the type of fault. See 6.6Section)			

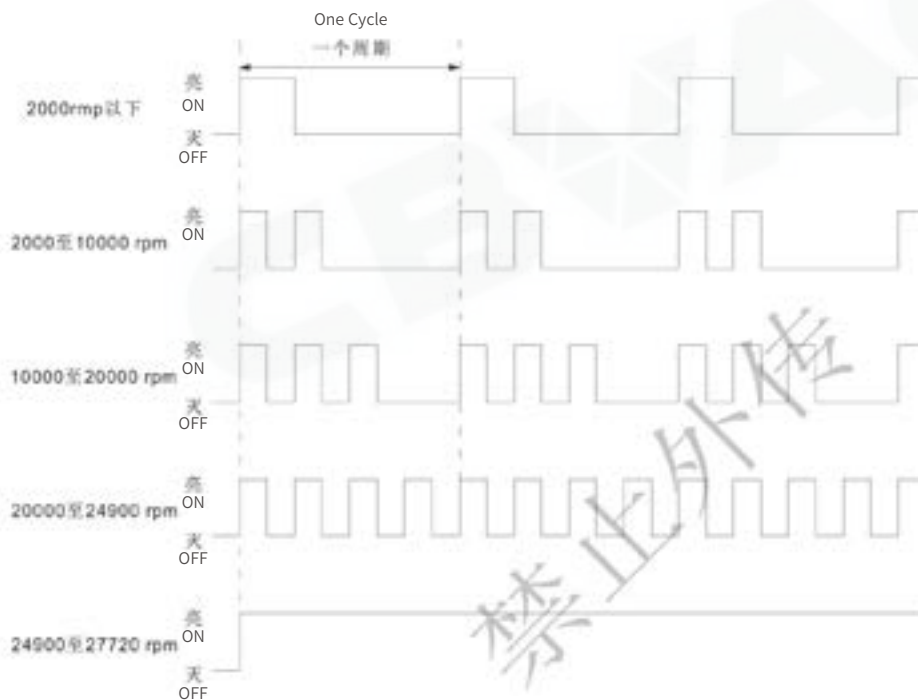


Figure27 Operating Status Indicator (taking the MTP-3201 series as an example)

2.5 REMOTE

The "REMOTE" port is used for interaction between the MTP pump and the REMOTE control signal. The connector used for the REMOTE port is D-Sub37 (female connector, with the connecting screw being imperial #4-40).

Note: The product accessories do not include a D-Sub 37-pin male connector; it is recommended to use cables with a metallic shield, ensuring that the shields on both ends of the cable are grounded.

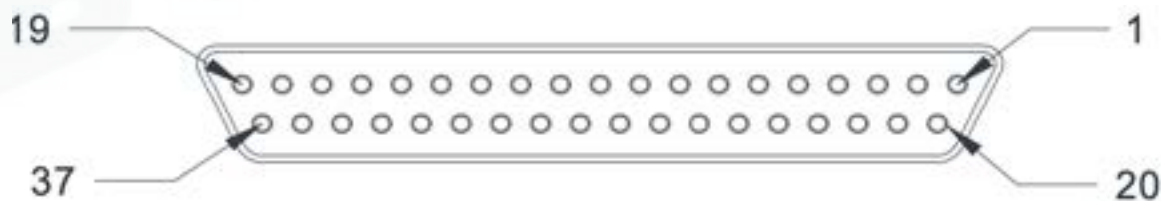


Figure28 REMOTE connector

Note: The REMOTE control input signal is only valid when the REMOTE control mode is enabled.
Table:15 Description of Passive Input Control Signal Pins

Pin numbering	definition	pinouts
1, 37	Common terminal	Common terminal (isolated from the casing)
19, 37	Selection of input signal type	When using a passive input signal, disconnect pins 19 and 37.
3, 21	Start-stop control	The following two start-stop methods are available: 1、Keep pin 1 and pin 21 short-circuited, then short-circuit pin 3 and pin 21 and maintain operation of the molecular pump for at least 0.3 seconds; If the short-circuit operation is performed before the power is turned on, the duration of the short-circuit should be no less than 10 seconds; Disconnect pin 1 and pin 21 to stop the molecular pump. 2、Keep the short-circuited 1st and 3rd pins to operate the molecular pump; Disconnect pins 1 and 3 to stop the molecular pump; This method does not require the use of a 21-pin.
22	RESET	After the fault cause is eliminated, short-circuiting pin 1 and pin 22 for more than 0.3 seconds can reset the fault signal (the fault light goes out).
4	REMOTE control enable signal	When pin 1 and pin 4 are short-circuited, the control mode of the molecular pump is set to REMOTE control mode. At this time, the REMOTE control input signal is valid, and all control functions of the serial port, except for communication functions, are disabled.
5	Start-up inhibit signal	When pin 1 and pin 5 are disconnected, it is prohibited to start the molecular pump. If the molecular pump is in operation, disconnecting pins 1 and 5 will cause the molecular pump to shut down. Keep the short-circuit connection between pin 1 and pin 2 to enable this signal.
2	Disable the enable signal for the start-up function	When pin 1 and pin 2 are short-circuited, the inhibit start function is effective.
23	Second speed operation signal	When pin 1 is short-circuited to pin 23, the rotational speed switches from the normal operating state to the second operating speed; When the connection between pin 1 and pin 23 transitions from a short-circuited state to a disconnected state, the rotational speed switches from the second rotational speed operation to the normal operation state; When utilizing this feature, it is necessary to set the second speed operation to "enabled" through serial communication or the monitoring interface (see 3.4.18Section).

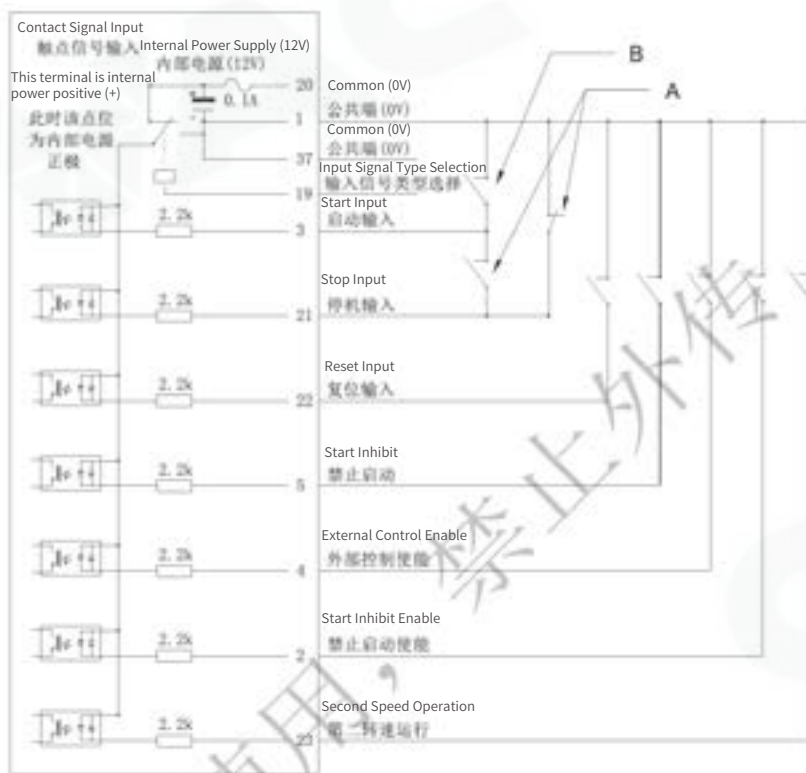
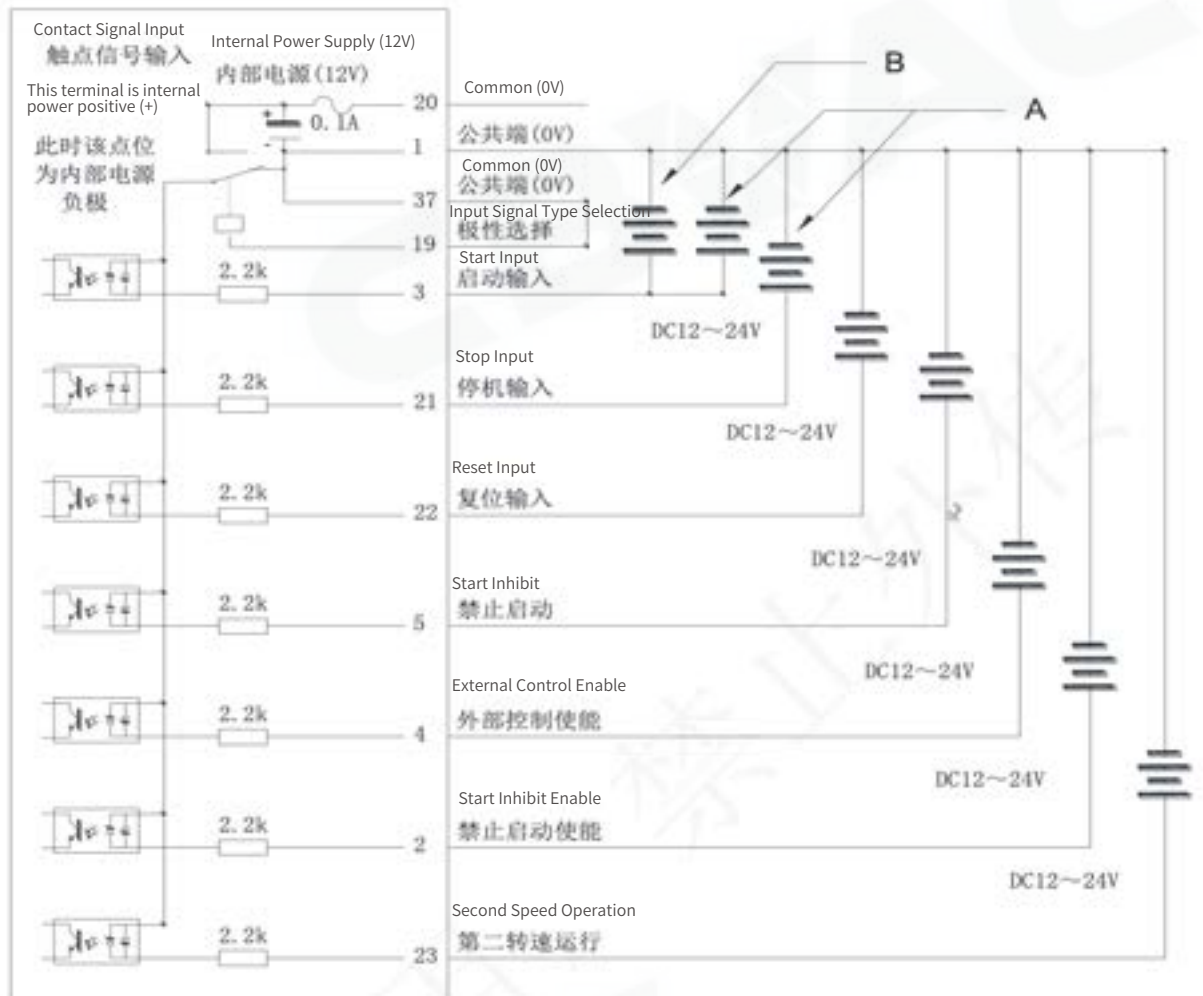


Table16 1: Description of active input control signal pins

Pin numbering	definition	pinouts
1. 37	Common terminal	Common terminal. When using active control, the common terminal is connected to the power supply reference ground.
19, 37	Selection of input signal type	When using an active input signal, short circuit pins 19 and 37.
3. 21	Start/stop signal	Two start-stop methods are available: 1、 Connect pin 21 to 12~24VDC, then connect pin 3 to 12~24VDC and maintain the connection for at least 0.3 seconds before starting the molecular pump; If the molecular pump has just been powered on, it requires a continuous power supply for at least 10 seconds before it can be started; disconnecting the power supply at pin 21 will stop the molecular pump. 2、 The molecular pump can be started by connecting 3 pins to 12~24VDC; Disconnect the power supply of pin 3 to stop the molecular pump.
22	RESET	After troubleshooting, the fault signal can be reset by connecting pin 22 to 12~24VDC for at least 0.3 seconds (the fault light goes out).
5	Start-up inhibit signal	When the 5-pin is disconnected from a 12~24VDC power supply, the molecular pump is prohibited from starting. If the molecular pump is currently running, disconnecting the 5-pin from the DC power supply will stop the molecular pump; Connecting 2 pins to 12~24VDC enables this function;
4	REMOTE Control enable signal	When the 4-pin is connected to 12~24VDC, the control mode of the molecular pump is set to REMOTE control mode. At this time, the REMOTE control input signal is valid, and all control functions of the serial port, except for the communication function, are disabled.
2	Prohibit enabling signal activation	When the 2-pin is connected to 12~24VDC, the enable/disable start signal is activated;
23	Second speed control signal	When the 23-pin is connected to 12~24VDC, the rotational speed transitions from the normal operating state to the second rotational speed; When the 12~24VDC supply to pin 23 is disconnected, the rotational speed transitions to the normal operating state;



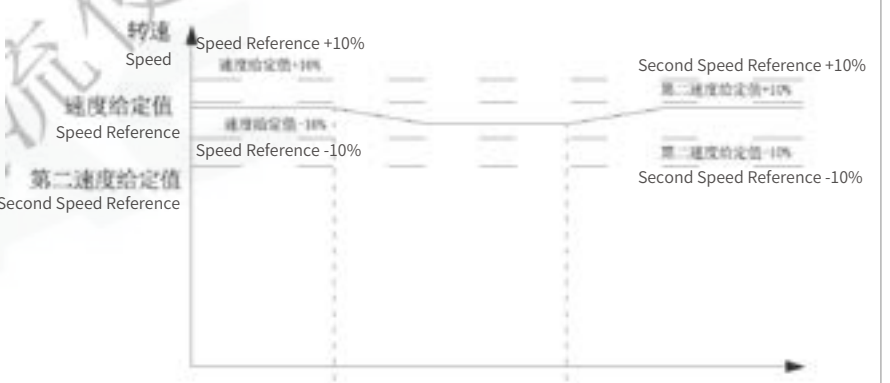
2.5.2 Remote control operation port settings

When using the REMOTE control function, the "remote operation mode" signal needs to be changed to parallel port through the "port selection input" signal of the REMOTE port. When the "port selection input" signal is turned off, regardless of how the "remote operation mode" is set, the control port will automatically be set to parallel port. When the "port selection input" signal is turned on, any control port can be selected in remote operation mode.

The default setting for remote operation mode is "I/O REMOTE" (parallel port).

REMOTE port	Control Selection	
	REMOTE	COM1 to COM3
Short circuit pin 1 and pin 4, or provide 12~24VDC (*1)	parallel port	parallel port
Disconnect pin 1 and pin 4, or disconnect 12~24VDC (*1)	parallel port	Serial ports (COM1 to COM3)

*1: The 1st pin of the REMOTE connector serves as the reference ground for the power supply

Setting Range	Pump status																								
The difference between the target rotational speed value and the second speed target value exceeds 10%	When the rotational speed decreases, the MTP pump enters braking mode. When the rotational speed increases, the MTP pump enters acceleration mode.  <table><tr><td>Operation Status</td><td>Normal Operation</td><td>Braking</td><td>Normal Operation</td><td>Acceleration</td><td>Normal Operation</td></tr><tr><td>运行状态</td><td>正常运行</td><td>制动</td><td>正常运行</td><td>加速</td><td>正常运行</td></tr><tr><td>第二速度状态</td><td>关闭</td><td>开启</td><td>关闭</td><td>关闭</td><td>关闭</td></tr><tr><td>Second Speed Status</td><td>OFF</td><td>ON</td><td>OFF</td><td>OFF</td><td>OFF</td></tr></table>	Operation Status	Normal Operation	Braking	Normal Operation	Acceleration	Normal Operation	运行状态	正常运行	制动	正常运行	加速	正常运行	第二速度状态	关闭	开启	关闭	关闭	关闭	Second Speed Status	OFF	ON	OFF	OFF	OFF
Operation Status	Normal Operation	Braking	Normal Operation	Acceleration	Normal Operation																				
运行状态	正常运行	制动	正常运行	加速	正常运行																				
第二速度状态	关闭	开启	关闭	关闭	关闭																				
Second Speed Status	OFF	ON	OFF	OFF	OFF																				
The difference between the target rotational speed value and the second speed target value is less than 10%	The speed variation is shown in the following figure  <table><tr><td>Operation Status</td><td>Normal Operation</td></tr><tr><td>运行状态</td><td>正常运行</td></tr><tr><td>第二速度状态</td><td>关闭</td><td>开启</td><td>关闭</td></tr><tr><td>Second Speed Status</td><td>OFF</td><td>ON</td><td>OFF</td></tr></table>	Operation Status	Normal Operation	运行状态	正常运行	第二速度状态	关闭	开启	关闭	Second Speed Status	OFF	ON	OFF												
Operation Status	Normal Operation																								
运行状态	正常运行																								
第二速度状态	关闭	开启	关闭																						
Second Speed Status	OFF	ON	OFF																						

2.5.4 Prohibit starting function

The "start-up inhibit" signal can only be triggered after enabling the "start-up inhibit" function by shorting pins 1 and 2 of the REMOTE terminal.

The relationship between the "start inhibit" signal and the operating state of the MTP pump is shown in Table 19.

Signal input description	Schematic diagram of signal input	Pump status
First, disconnect the "start inhibit" signal (A), and then input the "start" signal (B).		Upon receiving the "start" signal (B), the MTP pump initiates the execution of the start command.
First, input the "start" signal (A), and then disconnect the "start inhibit" signal (B).		After the "start" signal (A) is input, the MTP pump does not execute the start command. After the "start inhibit" signal (B) is turned off, the MTP pump starts executing the start command.
During operation, input the "start inhibit" signal (A).		Upon receiving the "start inhibit" signal (A), the MTP pump executes the command to slow down and shut down. After disconnecting the "start inhibit" signal, the MTP pump can only be restarted by inputting the "start" signal.

2.5.5 REMOTE control output port

The status of the REMOTE control output port is achieved through the on/off state of relays (CR1-CR8). Whether in REMOTE control mode or serial port control mode, the REMOTE control output port remains effective.

The table below displays the rated contact capacity of Figure 31relays CR1 to CR9.

category	Rating	Rated current	Maximum current	Maximum switching capacity	Minimum load
parameter	30VDC/0.5A	0.5A	0.5A	DC: 15W	10 mVDC/10uA

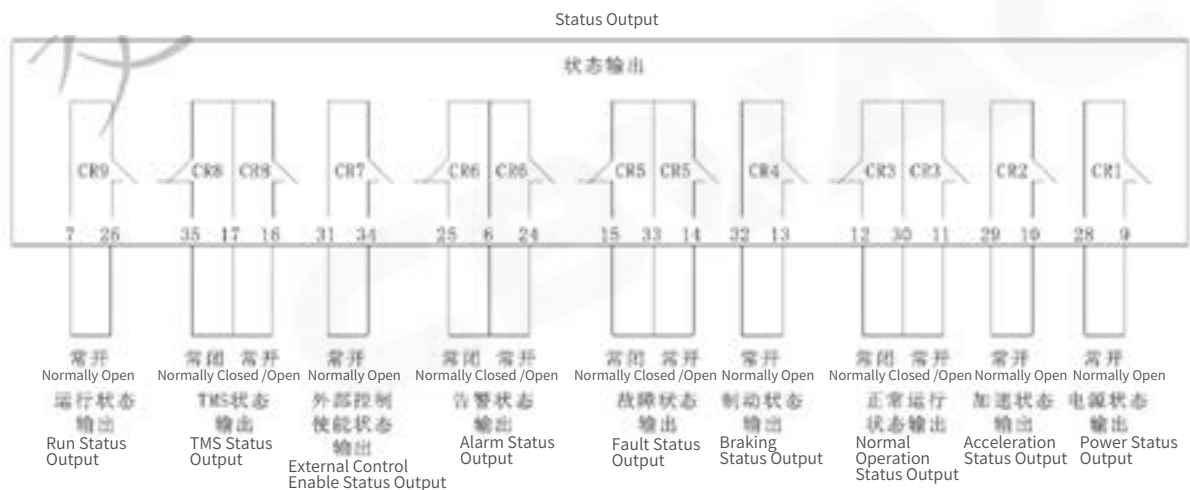


Figure 31 Schematic diagram of output state

Table 21 Description of REMOTE control output signal pins

definition	Pin	Contact state	Operating Instructions
Power status output	9, 28	normally open	It is closed during normal operation and disconnected in case of external power failure
Output in acceleration state	10, 29	normally open	Closed under acceleration
Output under normal operating conditions	11, 30	normally open	Close when reaching the set speed
	12, 30	normally closed	Disconnect when reaching the set speed
Output in deceleration (braking) state	13, 32	normally open	Closed during deceleration (braking)
Fault state output	14, 33	normally open	Closed in case of failure
	15, 33	normally closed	Disconnect in case of failure
Alarm status output	24, 6	normally open	Closed in alarm state
	25, 6	normally closed	Disconnect in alarm state
REMOTE control enables output	34, 31	normally open	Closed when using REMOTE control mode
Temperature reaches the state output	16, 17	normally open	It closes when the temperature of the MTP pump body reaches $\pm 10^{\circ}\text{C}$ of the TMS function set temperature.
	35, 17	normally closed	Disconnect when the temperature of the MTP pump body reaches $\pm 10^{\circ}\text{C}$ of the TMS function set temperature.
Operational status output	7, 26	normally open	When the second speed option is set to "enabled", and the second speed is selected, it closes.

2.6 TMS function (optional)

2.6.1 inspect

Please make sure to confirm:

- (一) Is the connection between the cable of the TMS heating unit and the "TMS" interface on the front panel of the controller safe and reliable.
- (二) Is the pipeline connection of the TMS cooling unit safe and reliable.

2.6.2 Start/Stop

When the power supply of the MTP pump is turned on/off, the TMS function will automatically start/stop. When the MTP pump is in a fault protection state, the TMS function will also automatically stop running.

2.6.3 working process

When the base temperature of the MTP pump falls below the temperature setting value of the TMS function, the TMS heating unit operates while the TMS cooling unit is turned off. When the temperature of the TMS function exceeds the set value, the TMS heating unit is turned off and the cooling unit is turned on. This process is repeated to maintain a constant temperature of the MTP pump body.

3 Serial communication protocol

3.1 brief introduction

The MTP pump is equipped with serial communication interfaces including RS232 and RS485. Through these serial communication interfaces, operating parameters can be configured, control commands can be issued, and the current status can be queried.

The MTP pump features two hardware serial communication ports: a COM1 port compatible with RS232/485 and a COM2 port exclusively compatible with RS485. Both ports enable communication with the host computer and control of the MTP pump. Additionally, the RS485 port supports PROFIBUS (optional). Furthermore, the monitoring module interface can be externally connected to an optional monitoring module, allowing full command control and status display of the MTP pump through the monitoring module.

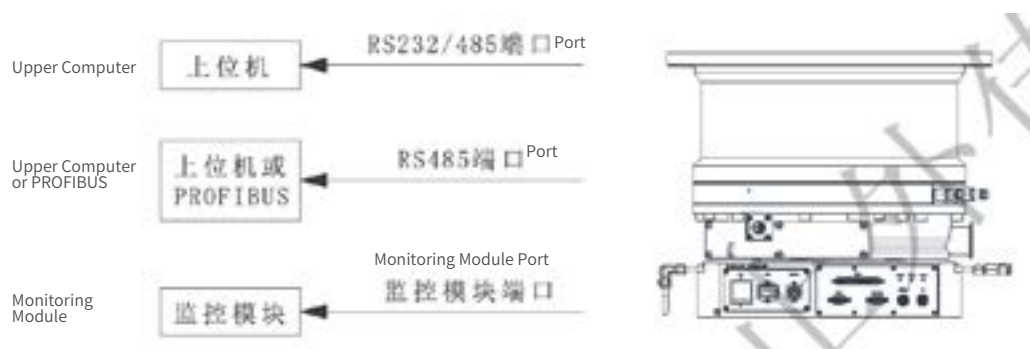


Figure32 Serial Port (taking MTP-3201CTMS(ISO320F) as an example)

3.2 set up

3.2.1 Communication Port

- (一) Monitoring module interface: used for connecting the monitoring module (optional).
- (二) COM1 RS232/485 port: Serial communication can be achieved via RS232 or RS485. To ensure communication quality, the length of the communication cable must not exceed 15 meters when using RS232 communication.
- (三) COM2 RS485 port: Supports serial communication or PROFIBUS communication via RS485 (optional).
- (四) The connectors used for the COM1 RS232/485 interface and COM2 RS485 interface are both D-Sub9 (female connector, with connecting screws of imperial #4-40). Refer to the schematic diagram for the ports Figure 33. For the pin definitions of the ports, please refer to Table 22.

Table: 22RS232/485 and RS485 pin positions

Communication mode	RS232/485 port (D-Sub 9-pin)	RS485 port (D-Sub 9-pin)
RS232	2 (TxD)	-
	3 (RxT)	-
	5 (GND)	-
RS485	7 (D-)	7 (D-)
	8 (D+)	8 (D+)
PROFIBUS (optional)	-	3 (D-)
	-	8 (D+)
reserve	1, 4, 6*1, 9	1, 2, 4, 5, 6, 9

The 6-pin of the RS232/485 port has an output voltage of 7VDC. Please do not use this pin, otherwise it may damage the peripheral devices.

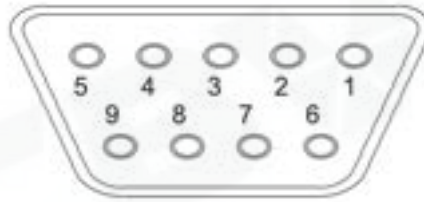


Figure 33 Schematic diagram of pins for RS232/485 and RS485 connectors

3.2.2 Recommendations for communication cables

Factors such as the type, length, communication rate, and differences in communication devices of communication cables can affect the quality of serial communication. It is recommended to use shielded cables or add EMI circuits. Depending on the actual working environment, different grounding measures should be taken to improve communication quality.

(一) Both ends are grounded (electromagnetic shielding)

The two ends of the shielding layer of the communication harness are both connected to GND, which can minimize the noise interference generated by the communication power supply, reduce the potential difference of the signal reference ground between the host computer terminal and the serial port of the MTP pump, and improve the communication quality.



Figure 34 Grounding Example (Both Ends Grounded)

(二) Single-point grounding (electrostatic shielding)

Since serial communication employs differential signals, maintaining a single-point grounding on the host computer side can reduce interference caused by external interference sources.



Figure 35 Grounding Example (Single-point Grounding)

1. Communication lines should be situated as far away as possible from strong interference environments and should be avoided close to power cables;
2. Place magnetic rings at both ends of the communication cables. The magnetic rings can reduce interference within the frequency range of (150kHz-1GHz);
3. The communication cables are kept secure;
4. Lay communication cables separately within metal conduits as much as possible, and prohibit the simultaneous laying of power cables and communication cables within the same metal conduit;

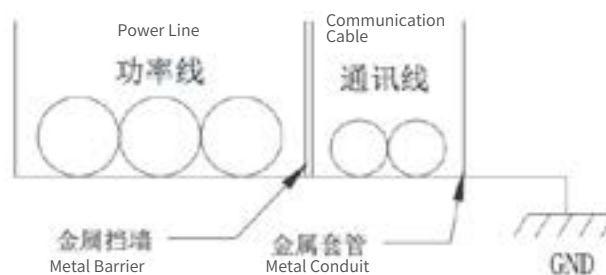


Figure: 36 Example of cable installation in metal pipelines

Note:

- (一) When powering on the MTP pump, do not plug or unplug the communication cable.
- (二) The communication interface is an electrostatic sensitive circuit, so please take anti-static measures during operation.
- (三) In case of communication abnormalities, a measuring instrument (such as an oscilloscope) can be used to check whether the communication waveform is normal.

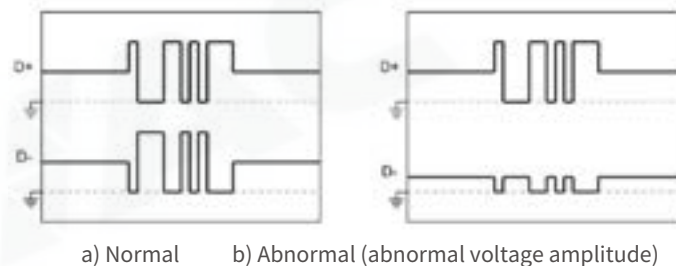


Figure37 Example of differential signal waveform

3.2.3 rs485 communication

When using the RS232/485 port or RS485 port for RS485 communication, please ensure to confirm the following items:

- (一) When the host computer is connected to multiple MTP pumps, the number of MTP pumps must not exceed 32.
- (二) The minimum response time for the MTP pump return is 5 ms, and the transmission/reception switching time of the host computer must not exceed 5 ms.
- (三) When using twisted-pair cables as communication cables, the cable length should be less than 1.2km. Terminal resistors (typical value 120Ω) should be configured at both ends of the communication cable.



Figure38 RS485 one-to-one connection method

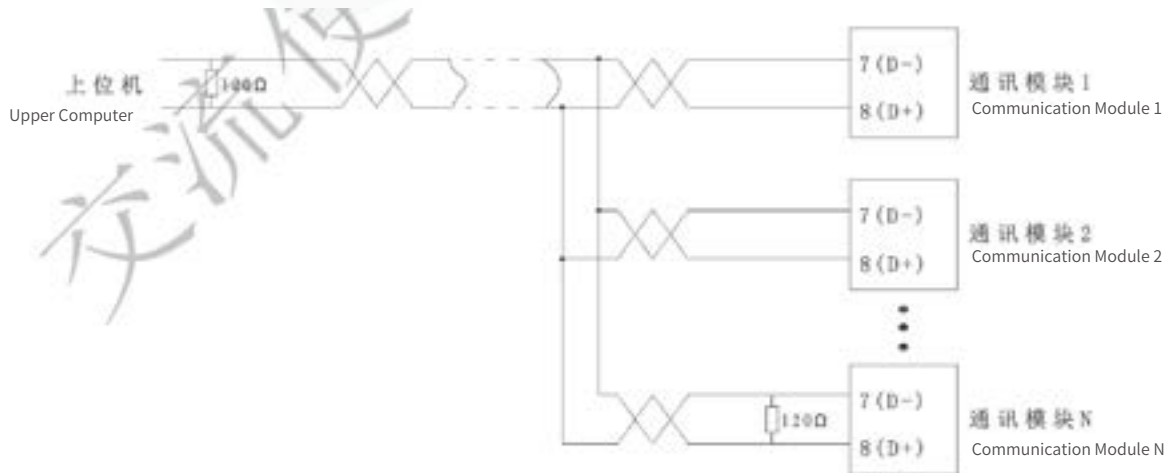


Figure39 RS485 one-to-many connection mode

3.2.4 Factory parameters and settings

The factory parameters for the RS232/485 and RS485 ports are as follows. You can use the monitoring module (optional) or contact after-sales service to change the communication parameters.

Table23 Communication Parameters

Communication parameters		Factory default parameters	Upper computer setting range
Baud rate		9600 bps	1200-56000 bps
Bit length		8 bit	7, 8 bit
stop bit		1 bit	1, 2 bit
check		None	None, Even, Odd
port	RS232/485	RS232/RS485 single point	RS232/RS485 single point RS485 multipoint
	RS485	RS485 single point	RS485 single point RS485 multi-point
RS485 ID (one-to-many)		1	1-127

3.2.5 Communication port setting

The operation steps for configuring the operation port as a serial port are as follows:

1. Disconnect the "Port Selection" signal between pin 1 and pin 4 of the REMOTE port. Otherwise, the control port will automatically be configured as the REMOTE port, and the control command function of the serial port will be disabled.
2. Change the operation port to a serial port according to the reference section.3.4.15

Table: 24Control Port

port type	Control port	notes
Parallel serial port	REMOTE port	REMOTE connector
serial port	COM1 RS232/485 port	RS232/485 connector
	COM2 RS485 port	RS485 connector, PROFIBUS (optional)
	COM3 monitoring module port	Monitoring module (optional)

Note: All commands, except for the MTP pump control commands, take effect simultaneously on any port.

3.2.6 Serial communication timeout setting

During the operation of the MTP pump, if the serial communication interruption time exceeds the set value, the MTP pump will trigger communication timeout protection and slow down to a halt. The interruption duration of communication timeout can be changed through serial communication or the monitoring module (optional). When set to "0", it indicates that the interruption of communication timeout will not be triggered, and the default setting is 1 minute. The setting of communication timeout duration is valid for all serial ports.

Table:25 Communication Timeout Duration Setting Parameters Table

	Presets	set range	notes
Communication timeout duration setting	1 minute	0 to 500 minutes (in steps of 1 minute)	Set to 0 to disable this function.

Note: When the communication timeout function is disabled, under certain special circumstances (such as a broken communication cable), the MTP pump may not be able to be controlled to shut down. It can be urgently shut down through the EMO circuit or by directly powering off the MTP pump and maintaining it for at least 2 seconds. At this time, the MTP pump will trigger an "external power supply abnormal power-off" fault to achieve automatic protection shutdown.

3.3 Communication protocol

3.3.1 General description

During the operation of the MTP pump, if the serial communication interruption time exceeds the set value, the MTP pump will trigger communication timeout protection and slow down to a halt. The interruption duration of communication timeout can be changed through serial communication or the monitoring module (optional). When set to "0", it indicates that the interruption of communication timeout will not be triggered, and the default setting is 1 minute. The setting of communication timeout duration is valid for all serial ports.

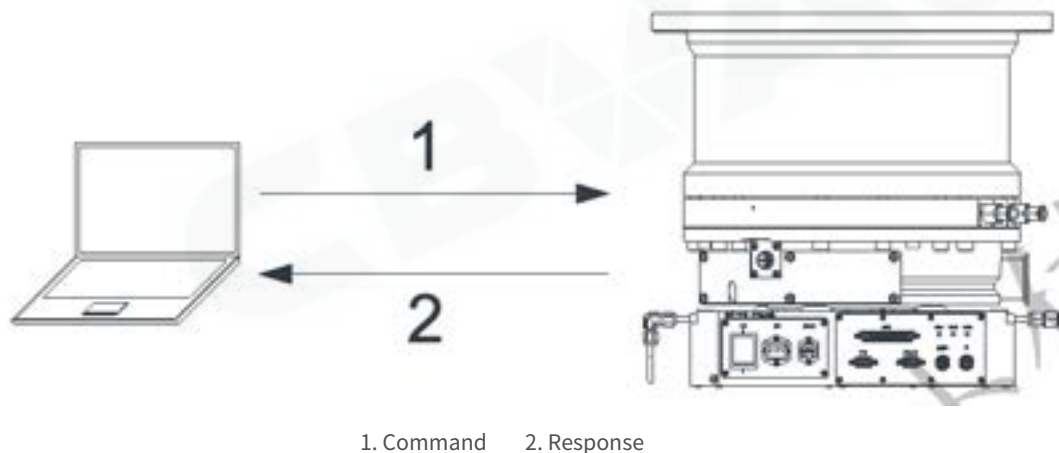


Figure40 Communication from the host computer to the MTP pump

Table26 Transmission Control Character

	ASCII characters	hexadecimal code	function
Transport layer	STX	02	Start character of the transmission block
	ETX	03	End character of transmission frame
	ETB	17	End character of a non-final transmission block
	ACK	06	Correctly receive the identifier
	NAK	15	The identifier was not received correctly
	@	40	Grid frame ID character
application layer	#	23	Correctly execute the identifier
	!	21	Identifier not executed correctly

3.3.2 Transmission data format

The transmitted data is in the form of hexadecimal encoding, and its value needs to be obtained by converting it into hexadecimal encoding according to ASCII text.

Example: The data value to be transmitted is 12090 in decimal, which equals 2F3AHEX in hexadecimal. When converted to hexadecimal encoding using ASCII text, the value becomes: 32 46 33 41, which represents the actual data transmitted.

3.3.3 Frame control (checksum)

The transmission frame undergoes parity check detection. First, initialize the LRC (checksum) to FFHEX. Next, perform an XOR (exclusive OR) calculation on the LRC, computing all bytes in the frame that contain "STX", "ETB", and "ETX".

Example: Calculate the string before LRC (LRC position is the initial value FFHEX):

ASCII	STX	0	0	1	#	ETX	LRC
HEX	02	30	30	31	23	03	FF

Calculation of LRC:

02HEX XOR 30HEX XOR 30HEX XOR 31HEX XOR 23HEX XOR 03HEX XOR FFHEX = ECHEX

Calculate the string used for transmission after LRC:

ASCII	STX	0	0	1	#	ETX	LRC
HEX	02	30	30	31	23	03	EC

When the data length is 7 bits and the MSB (most significant bit) is always 0, the LRC is set to 6CHEX by ECHEX.

3.3.4 control error

The MTP pump is equipped with a communication error redundancy function, which is described as follows:

(一) When the MTP (Magnetic Suspension Molecular Pump) returns "NAK" (Not Acknowledged, indicating a verification error), the host computer will resend the transmission frame repeatedly;

(二) When the MTP (Magnetic Suspension Molecular Pump) receives "NAK" from the host computer, the data frame will be transmitted again;

(三) The above operation can be repeated up to 5 times.

After the communication command is received, the MTP pump sends "ACK" or "NAK" to the host computer. If the host computer does not receive "ACK" or "NAK" after 2 seconds, please resend the transmission frame from the host computer.

When these communication statuses occur repeatedly, error messages will be displayed on the monitoring module or the host computer.

3.3.5 RS232/RS485 single-point connection: standard transmission frame

The transmission frame consists of a single transmission block or multiple transmission blocks. A transmission block comprises a start control character, a transmission block number, a message (up to 255 characters), an end control character, and a checksum (LRC).

(一) The number of characters in the transmission frame is less than 256:

Character serial number	1	2	3	4	5	.....	5+n	5+n+1	5+n+2
ASCII	STX	0	0	1	C ₁		C _n	ETX	LRC

"STX": the starting character of the transmission block;

"ETX": The end character of the transmission frame.

(二) The transmission frame contains a telegram character count of ≥ 256 (total telegram characters = $k \cdot n + m$, where $n=255$, $m \leq 255$, and k =number of transmission blocks):

The first one Transmission block	Character serial number	1	2	3	4	5	.....	5+n	5+n+1	5+n+2
	ASCII	STX	0	0	1	C ₁₋₁		C _{1-n}	ETB	LRC

final Transmission block	Character sequence number	1	2	3	4	5	.....	5+n	5+n+1	5+n+2
	ASCII	STX	k	C _{k-1}	2	C ₂₋₁		C _{k-m}	ETX	LRC

"ETX": The end character of the transmission frame.

SP	CHR	C _i		C _n
----	-----	----------------	-------	----------------

STX	0	0	1	SP	CHR	C ₁	.....	C _n	ETX	LRC	
											ACK or NAK

2. When the MTP pump correctly receives the control command, it executes the received control command;

3. The MTP (Magnetic Suspension Molecular Pump) sends the following transmission frames to the host computer, and the host computer sends feedback characters "ACK" or "NAK" to the MTP pump:

MTP pump → host computer

Host computer → MTP pump

STX	0	0	1	#or!	ETX	LRC	
							ACK or NAK

4. Send the next command as required.

(二) When there are two transmission frames, that is, $256 \leq \text{message characters} < 512$, and $254 \leq \text{parameter characters} < 510$ ($n < 510$):

1. The host computer sends a control command (the first transmission frame) to the MTP pump, and the MTP pump sends back a character "ACK" or "NAK" to the host computer:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	CHR	C ₁	.....	C ₂₅₃	ETB	LRC	
											ACK or NAK

2. When the MTP pump correctly receives the control command, the host computer continues to send control commands (the second transmission frame) to the MTP pump, and the MTP pump sends a feedback character of "ACK" or "NAK" to the host computer:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	C ₂₅₄	.....	C _n	ETX	LRC	
								ACK or NAK

3. When the MTP pump correctly receives the control command, it executes the received control command;

4. The MTP (Magnetic Suspension Molecular Pump) sends the following transmission frames to the host computer, and the host computer sends feedback characters "ACK" or "NAK" to the MTP pump:

MTP pump → host computer

Host computer → MTP pump

STX	0	0	1	#or!	ETX	LRC	
							ACK or NAK

5. Send the next command as required.

3.3.7 RS232/RS485 single-point connection: query command

Use the query command to read the operating status and set values of the pump. The command format is as follows:

?	CHR	C ₁		C _n
---	-----	----------------	-------	----------------

"?": Query command identifier, with a value of 3FHEX;

CHR: Function code. For specific explanation, refer to Table 28 Function Code List.

C₁ to C_n: Parameters. The parameters (C₁ to C_n) are represented in ASCII using hexadecimal encoding. When the message (including '?', CHR, and parameters) exceeds 255 characters, only the first transmission frame will send '?' and CHR, while the second and subsequent transmission frames will not send '?' and CHR.

(一) When there is only one transmission frame, i.e., the number of telegram characters is less than 256 and the number of parameter characters is less than 254 (n<254); and when using two transmission frames for return, the host computer sends a query command to the MTP pump, and the MTP pump sends feedback characters "ACK" or "NAK" to the host computer:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	CHR	C ₁	.....	C _n	ETX	LRC	
											ACK or NAK

(二) When the MTP pump correctly receives the query command, it executes the received query command and sends the first transmission frame containing query information to the host computer. The host computer then sends a feedback character of "ACK" or "NAK" to the MTP pump:

MTP pump → host computer

Host computer → MTP pump

STX	0	0	1	SP	CHR	C ₁	.....	C ₂₅₃	ETB	LRC	
											ACK or NAK

(三) When the host computer correctly receives the first transmission frame, the MTP pump sends the second transmission frame containing query information to the host computer, and the host computer sends a feedback character of "ACK" or "NAK" to the MTP pump:

MTP pump → host computer

Host computer → MTP pump

STX	0	0	2	C ₂₅₄	.....	C _n	ETX	LRC	
									ACK or NAK

(四) Send the next command as required.

3.3.8 RS485 multi-drop connection: standard transmission frame

To identify a network frame and ensure compatibility with standard transmission frames, three characters are added to the transmission frames of RS485 multi-drop connections: one network frame ID character "@" and two network frame ID numbers.

The network frame ID number is used to identify the MTP pump, with a range from 1 to 127. The interpretation method is as follows: first, convert the network frame ID number to hexadecimal encoding format, and then convert each bit to hexadecimal encoding according to ASCII text to obtain the characters of the transmission frame.

Example: Network frame ID characters and numbers in multi-point connection:

ASCII	@	0	1	Network frame ID number "1"
HEX	40	30	31	
ASCII	@	6	4	Network frame ID number "100"
HEX	40	36	34	
ASCII	@	7	F	Network frame ID number "127"
HEX	40	37	46	

The transmission frame consists of a single transmission block or multiple transmission blocks. A transmission block comprises a network frame ID character, a network frame ID number, a start control character, a transmission block number, a message (up to 255 characters), an end control character, and a check sum (LRC).

(一) The number of characters in the transmission frame's report is less than 256:

	1	2	3	4	5	6	7	8	.....	8+n	8+n+1	8+n+2
ASCII	@	F ₁	F ₂	STX	0	0	1	C ₁		C _n	ETX	LRC

"@": network frame ID character;

"STX": the starting character of the transmission block;

"ETX": End of Transmission Frame character.

(二) The number of characters in the transmission frame's message is ≥ 256 (total number of characters in the message = $k \cdot n + m$, where $n=255$, $m \leq 255$, and k =number of transmission frames):

The first transmission frame		1	2	3	4	5	6	7	8	.....	8+n	8+n+1	8+n+2
	ASCII	@	F ₁	F ₂	STX	0	0	1	C ₁₋₁		C _{1-n}	ETB	LRC

Second transmission frame		1	2	3	4	5	6	7	8	.....	8+n	8+n+1	8+n+2
	ASCII	@	F ₁	F ₂	STX	0	0	2	C ₂₋₁		C _{2-n}	ETB	LRC

final Transmission frame		1	2	3	4	5	6	7	8	.....	8+n	8+n+1	8+n+2
	ASCII	@	F ₁	F ₂	STX	k			C _{k-1}		C _{k-m}	ETX	LRC

'@': network frame ID character;

"STX": the starting character of the transmission block;

"ETB": End of Transmission Block;

"ETX": End of Transmission Frame character.

3.3.9 RS485 multi-drop connection: control command

The control commands include operation commands and setting change commands for the MTP pump, and their command formats are as follows:

SP	CHR	C ₁		C _n
----	-----	----------------	-------	----------------

"SP": space character, control command identifier, with a value of 3FHEX;

CHR: Function code. For specific explanation, refer to Table 28;

C₁ to C_n: Parameters. The parameters (from C₁ to C_n) are represented as ASCII encoded hexadecimal values. When the message (SP, CHR, and parameters) exceeds 255 characters, only "SP" and CHR are sent in the first transmission frame of the transmission frame, and "SP" and CHR are not sent in the second and subsequent transmission frames.

When the control command is executed correctly, the MTP pump returns a correct execution identifier "#". Otherwise, the MTP pump returns an incorrect execution identifier "!", followed by three non-response codes.

(一) When there is only one transmission frame, i.e., the number of message characters < 256 and the number of parameter characters < 254 (n < 254):

1. The host computer sends control commands to the MTP pump, and the MTP pump sends feedback characters "ACK" or "NAK" to the host computer:

Host computer → MTP pump

MTP pump → host computer

@	F ₁	F ₂	STX	0	0	SP	CHR	C ₁		C _n	ETX	LRC	ACK or NAK			F ₁	F ₂
---	----------------	----------------	-----	---	---	----	-----	----------------	-------	----------------	-----	-----	------------	--	--	----------------	----------------

2. When the MTP pump correctly receives the control command, it executes the received control command:

3. The MTP (Magnetic Suspension Molecular Pump) sends the following transmission frames to the host computer, and the host computer sends feedback characters "ACK" or "NAK" to the MTP pump:

MTP pump → host computer

Host computer → MTP pump

@	F ₁	F ₂	STX	0	0	1	#or!	ETX	LRC	ACK or NAK			F ₁	F ₂
---	----------------	----------------	-----	---	---	---	------	-----	-----	------------	--	--	----------------	----------------

4. Send the next command as required.

(二) When there are two transmission frames, that is, $256 \leq \text{message characters} < 512$, and $254 \leq \text{parameter characters} < 510$ (n < 510):

1. The host computer sends control commands to the MTP pump (the first transmission frame), and the MTP pump sends feedback characters "ACK" or "NAK" to the host computer:

Host computer → MTP pump

MTP pump → host computer

@	F ₁	F ₂	STX	0	0	SP	1	CHR	C ₁		C ₂₅₃	ETB	LRC	ACK or NAK			F ₁	F ₂
---	----------------	----------------	-----	---	---	----	---	-----	----------------	-------	------------------	-----	-----	------------	--	--	----------------	----------------

2. When the MTP pump correctly receives the control command, the host computer continues to send control commands (the second transmission frame) to the MTP pump, and the MTP pump sends a feedback character of "ACK" or "NAK" to the host computer:

Host computer → MTP pump

MTP pump → host computer

@	F ₁	F ₂	STX	0	0	2	C ₂₅₄		C _n	ETX	LRC				
												ACK or NAK		F ₁	F ₂

3. When the MTP pump correctly receives the control command, it executes the received control command:

4. The MTP (Magnetic Suspension Molecular Pump) sends the following transmission frames to the host computer, which then sends a feedback character of "ACK" or "NAK" to the MTP pump:

MTP pump → host computer

Host computer → MTP pump

@	F ₁	F ₂	STX	0	0	1	#or!	ETX	LRC			
										ACK or NAK	F ₁	F ₂

5. Send the next command as required.

3.3.10 RS485 multi-point connection: query command

Use the query command to read the operating status and set values of the pump. The command format is as follows:

?	CHR	C ₁		C _n
---	-----	----------------	-------	----------------

"?" : Inquiry command identifier, with a value of 3FHEX;

CHR: Function code, refer to for specific explanation Table 28;

C₁ to C_n: Parameters. The parameters (C₁ to C_n) are ASCII represented by hexadecimal encoding. When the message (?, CHR, and parameters) exceeds 255 characters, only the "?" and CHR are sent in the first transmission frame of the transmission frame, and the second and subsequent transmission frames do not send the "?" and CHR.

(一) When there is only one transmission frame, i.e., the number of telegram characters is less than 256 and the number of parameter characters is less than 254 (n<254); and when using two transmission frames for return, the host computer sends a query command to the MTP pump, and the MTP pump responds with the characters "ACK" or "NAK" to the host computer:

Host computer → MTP pump

MTP pump → host computer

@	F ₁	F ₂	STX	0	0	1	?	CHR	C ₁	.....	C _n	ETX	LRC				
														ACK or NAK		F ₁	F ₂

(二) When the MTP pump correctly receives the query command, it executes the received query command and sends the first transmission frame containing the query information to the host computer. The host computer then sends a feedback character of "ACK" or "NAK" to the MTP pump:

MTP pump → host computer

Host computer → MTP pump

@	F ₁	F ₂	STX	0	0	1	SP	CHR	C ₁	.....	C ₂₅₃	ETB	LRC				
														ACK or NAK		F ₁	F ₂

(三) When the host computer correctly receives the first transmission frame, the MTP pump sends the second transmission frame containing query information to the host computer, and the host computer sends a feedback character of "ACK" or "NAK" to the MTP pump:

MTP pump → host computer

Host computer → MTP pump

@	F ₁	F ₂	STX	0	0	2	C ₂₅₄	.....	C _n	ETX	LRC					
												ACK or NAK		F ₁	F ₂	

(四) Send the next command as required.

3.3.11 RS485 multi-drop connection: broadcast command

When the network frame ID is set to 0 (hexadecimal code "30"), it can enable all MTP pumps connected to the network to perform startup or shutdown operations, but each MTP pump does not provide any response feedback:

Host computer → MTP pump

MTP pump → host computer

@	0	0	STX	0	0	1	SP	E	parameter	ETX	LRC					
												no response				

parameter	project	data format	notes
1	Operation command	8-bit hexadecimal ASCII code	see

Table: 270 Operating commands for multipoint broadcasting of MTP pumps

Operation command	price
start	1
shutdown	2

3.3.12 precautions

Factors such as cable type and length, communication rate, and communication equipment can all affect communication quality. Therefore, it is essential to communicate in accordance with the communication protocol. Figure 41 Below is an example block diagram illustrating an effective communication process from command transmission to response data reception:

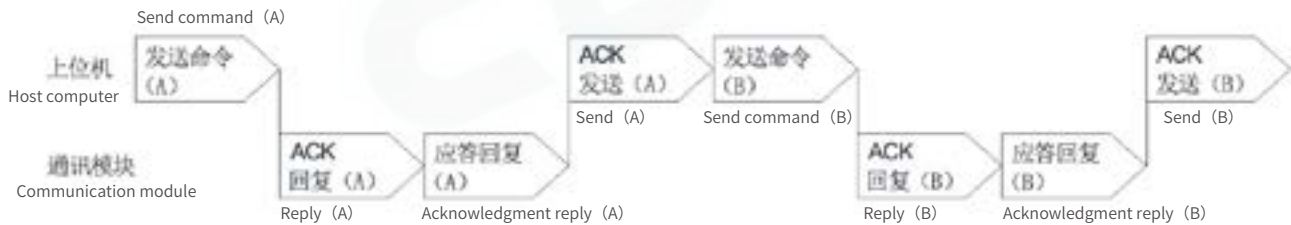


Figure41 Example block diagram of effective communication process

When the MTP pump receives a command, it will reply with "ACK" or "NAK" within approximately 2 seconds to indicate the reception status. If no reply is received, it indicates that the MTP pump may not have received the command, and the command should be resent. When the MTP pump fails to reply multiple times in succession, it is determined that there is a communication anomaly.

When the character "ETX" is received, it indicates that data reception is complete. After receiving "ETX", the reception of "LRC" (checksum) signifies the end of the acceptance process.

When receiving commands with different response data sizes, this process can improve communication efficiency. However, when judging the completion of the receiving process based on the number of received characters, please check whether "ETX" is received and whether the LRC checksum is correct.

After sending a command, the waiting timer needs to be reset to zero when response data is received. When a large amount of response data is received, the response process of the tool software may time out, potentially preventing the acquisition of all data.

During communication, always check the LRC checksum of the response data. If the LRC checksum is incorrect, do not use the received data and consider the communication as failed. You can receive the response data again according to the following method.

After receiving the response data, send "NAK" within 1500ms, and then receive the response and obtain data from the MTP pump. When using RS485, it takes at least 1ms after sending "NAK" to receive the response data.

If there is a communication anomaly, you can repeatedly attempt to re-establish communication:

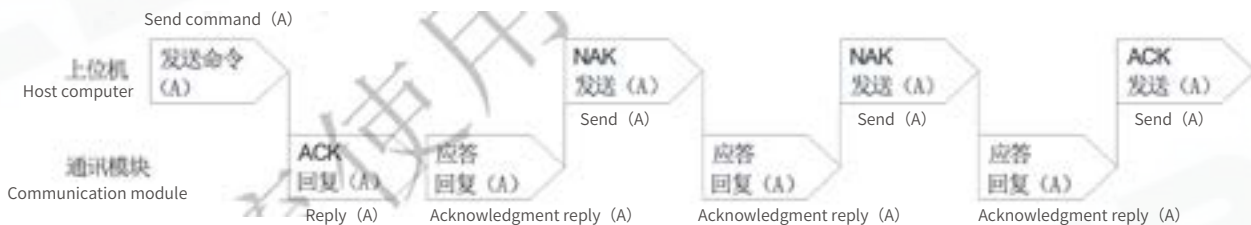


Figure42 Response reset process

When sending commands before receiving MTP pump data, the content of the response data may not match the sent command. In this case, please stop communication for about 5 seconds to clear all receive buffers of the tool software, and then restart communication:

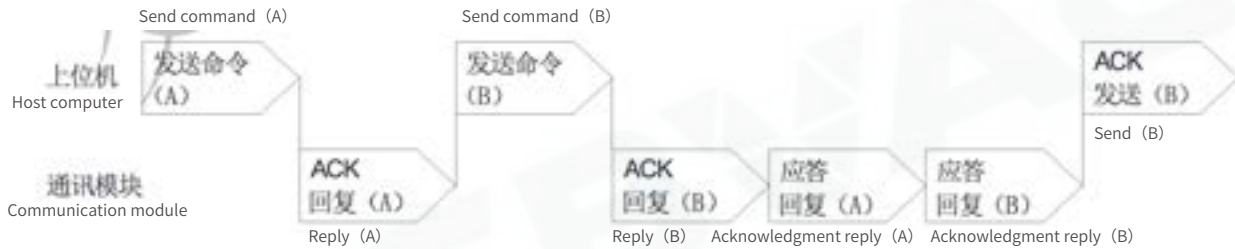


Figure43 Example response when commands are sent continuously

When using RS485, do not send commands while sending response data from the MTP pump, otherwise it may cause communication errors:

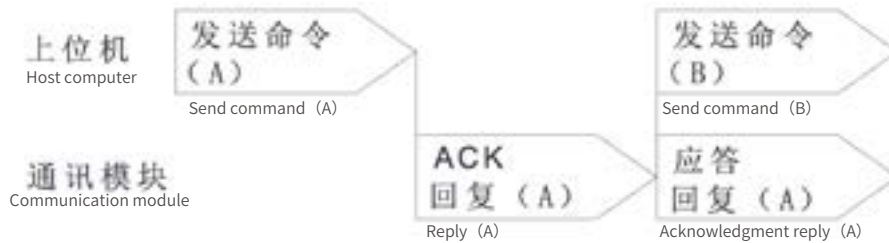


Figure44 Example of crosstalk caused by sending commands during data response process

If there is only one block, there is no need to consider the process within the dashed box.

若只有一个块则无需考虑虚框内的流程

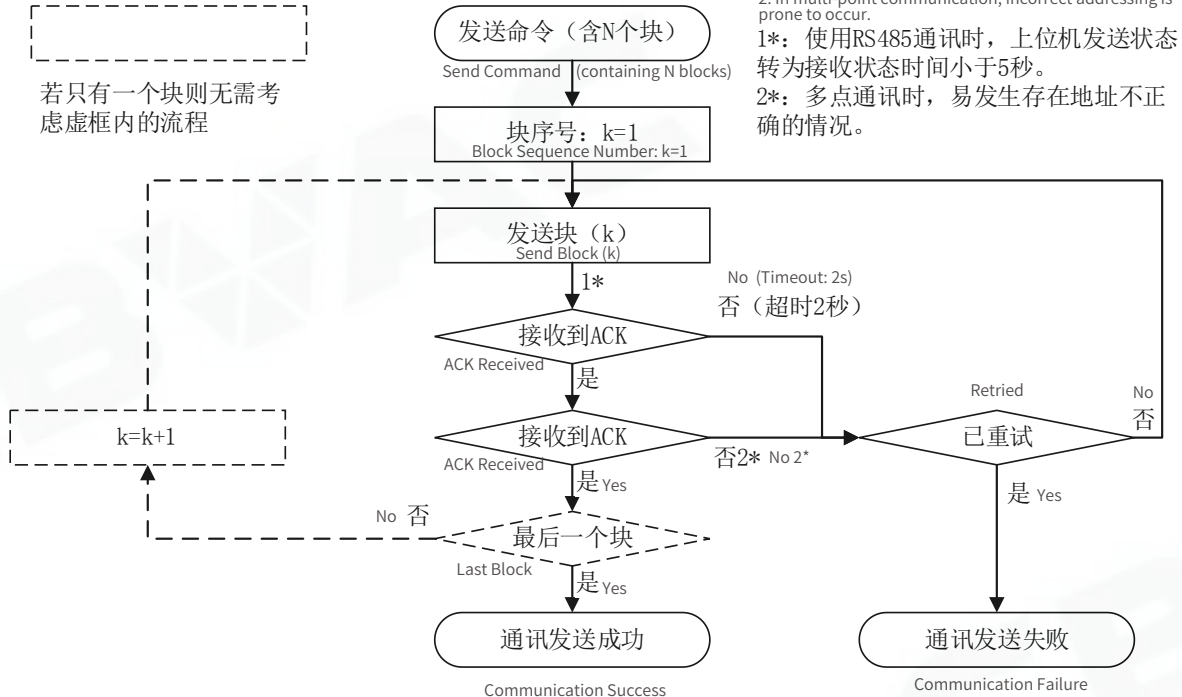


Figure45 Example of communication sending process

If there is only one block, there is no need to consider the process within the dashed box.

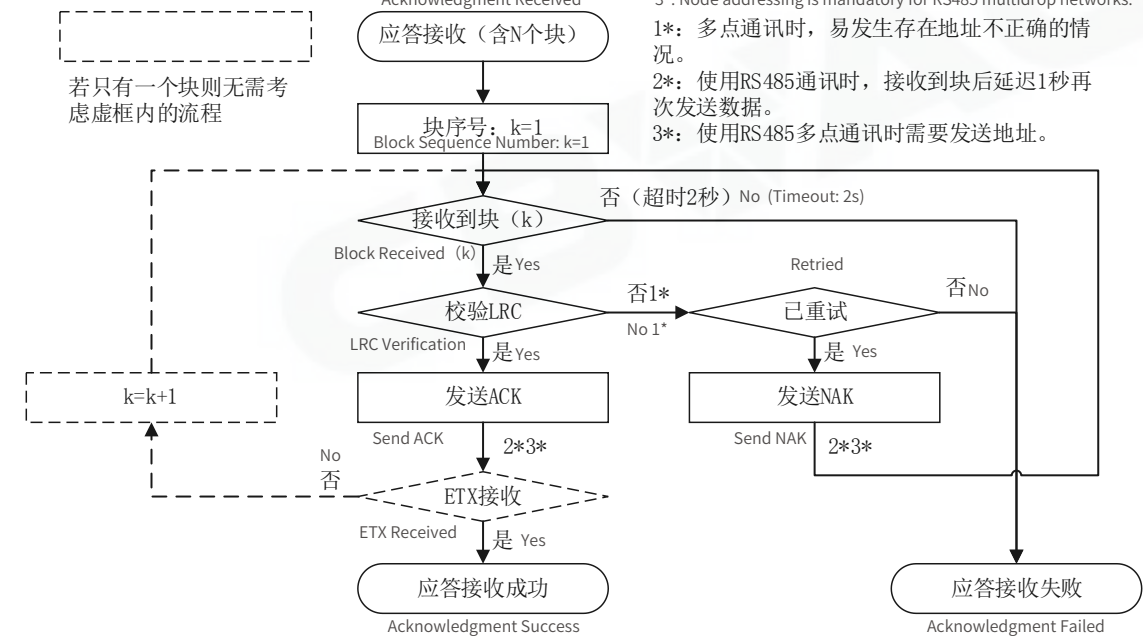


Figure46 Example of communication receiving process

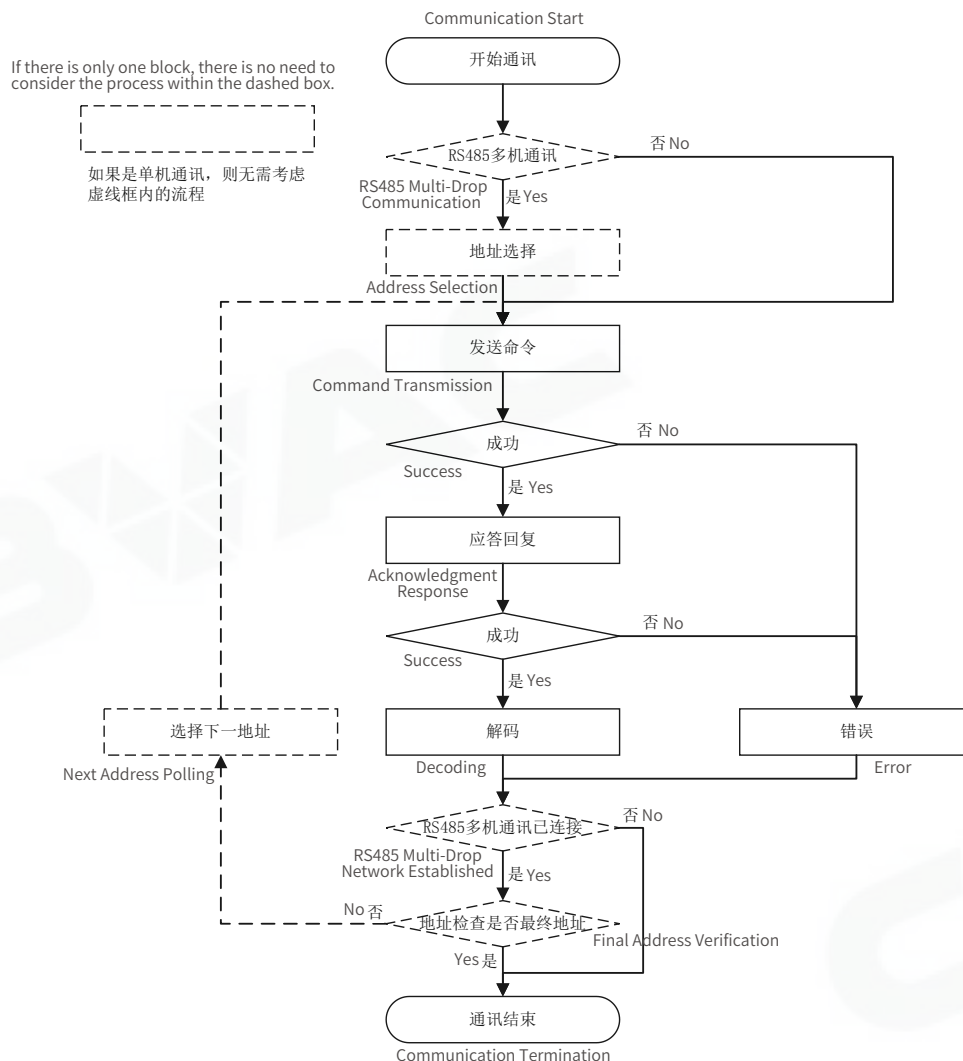


Figure47 Example of communication cycle process

3.4 Command specification

3.4.1 Function code list

Table: 28List of Function Codes

function code		Command/Query Name	function
?	D	Read real-time rotational speed	Read the measured rotational speed
SP	E	Issue operation command	Send start, stop, and reset commands (valid when the control port is set to the current serial port)
?	F	Read real-time error information	Read detected errors
?	M	Read operation mode and real-time error information	Read the pump operation mode and detect errors
?	d	Read the target rotational speed and the set value of TMS target temperature	Read the set values of the target rotational speed and TMS temperature
?	e	Read the temperature value of the motor	Read motor temperature
?	f	Read the settings of the control port, TMS, and emergency exhaust valve	Read various settings (control port, TMS function, and emergency exhaust valve)
SP	h	Set the target rotational speed setting value	Change speed setting
?	h	Read the set value of target rotational speed	Reading speed setting
?	m	Read operation mode, errors, and alarms	Read operation mode, errors, and alarms
?	g	Read the current error record	Read error record
?	[	Read the status of TMS, motor, and controller	Read TMS temperature, motor temperature, motor current, measured speed, and controller temperature
?	=	Read optional functions	Read each setting value of the project
SP	=	Set optional functions	Modify each setting value of the project
?	{	Read the status of the molecular pump	Read the model number and damaged points of the molecular pump
?	}	Read historical error records	Read error records with detection time
SP	0	Set the second speed function parameter	Change the second speed function setting (second speed option)
?	0	Read the second speed function parameter	Read the second speed function setting (second speed option)

3.4.2 Read real-time rotational speed

Function: Read the rotational speed of the MTP pump.

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	D	ETX	LRC	
								ACK

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	D	Parameters 1 to 2	ETX	LRC	
									ACK

parameter	project	data format	notes
1	System reservation	56-bit hexadecimal ASCII	
2	Measure rotational speed (unit: Hz)	16-bit hexadecimal ASCII	

Example: Real-time rotational speed: 01C2HEX = 450DEC: 450Hz (27000 rpm)

parameter	1														2			
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	0	1	C	2
HEX															30	31	43	32

*1: System reservation

3.4.3 Issue operation command

Function: Send MTP pump operation commands: start, stop, and reset. This command is valid when the control port is set to serial port.

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	E	Parameter 1	ETX	LRC	
									ACK

Host computer → MTP pump

MTP pump → host computer

							ACK
STX	0	0	1	#	ETX	LRC	

parameter	project	data format	notes
1	Operation command	Eight-bit hexadecimal ASCII	For operation commands, refer to

Table29 MTP Pump Operation Commands

Operation command	price
start	1
shutdown	2
reset	4

Example: Pump operation command: 04HEX = 04DEC: Reset

parameter	1	
ASCII	0	4
HEX	30	34

3.4.4 Read real-time error information

Function: Read the detected real-time error messages. These data are the same as the data from parameters 2 to 82 in the next section. The correspondence between error messages and numerical values is as follows:

Table:30 Error message values

fault information	price	fault information	price	fault information	price
RAM error	0	Loss of motor temperature detection signal	31	System reservation	62
EEPROM error	1	TMS temperature is too low	32	System reservation	63
TMS overheating 1	2	AMB communication failure	33	System reservation	64
TMS circuit breaker is open	3	System reservation	34	System reservation	65
TMS overheating 2	4	Loss of TMS detection signal	35	System reservation	66
Abnormal power loss of external power supply	5	System reservation	36	System reservation	67
Power Failure	6	System reservation	37	System reservation	68
Overspeed 1	7	System reservation	38	System reservation	69
Motor drive overvoltage	8	System reservation	39	System reservation	70
System reservation	9	System reservation	40	System reservation	71
Internal overheating of the controller 1	10	System reservation	41	Abnormal braking	72
Motor drive overcurrent	11	System reservation	42	Abnormal acceleration	73
Motor drive overload	12	Alarm: Unbalanced AY	43(*1)	TMS voltage mismatch	74
Disturbance AY	13	Alarm: Unbalanced BY	44(*1)	under voltage	75
Disturbance AX	14	Warning: Unbalanced Z	45(*1)	Magnetic bearing overcurrent	76
Disturbance BY	15	System reservation	46	fan failure	77
Disturbance BX	16	System reservation	47	Serial communication timeout	78(*2)
Disturbance Z	17	System reservation	48	System reservation	79
motor overheating	18	System reservation	49	System reservation	80
System reservation	19	Motor drive failure	50	System reservation	81
Internal overheating of the controller 2	20	System reservation	51	System reservation	82
System reservation	21	Abnormal motor identification resistance	52	System reservation	83
System reservation	22	Drive current fault	53	System reservation	84
System reservation	23	Cooling fan failure	54	System reservation	85
Motor drive communication failure	24	Drive CPU failure	55	System reservation	86
Warning: Level 1 damage limit	25(*1)	System reservation	56	System reservation	87
Warning: Level 2 damage limit	26	Magnetic bearing overcurrent	57	Overspeed 4	88
Not allowed to start	27	DSP initialization failed	58	System reservation	89
Loss of speed detection signal	28	Acceleration fault	59	Internal overheating of the controller 3	90
Overspeed 2	29	System reservation	60	Warning: Operation timeout	91(*1)
Overspeed 3	30	System reservation	61	Warning: Overload	92(*1)

*1: The "Attention" or "Alarm" message displayed at this time does not indicate that the MTP pump is in a fault state. The MTP pump continues to operate while the error message is displayed.

*2: When the communication timeout is set to "0", error 78 is disabled.

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	F	ETX	LRC	
								ACK

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	F	Parameters 1 to 81	ETX	LRC	ACK
-----	---	---	---	----	---	--------------------	-----	-----	-----

parameter	project	data format	sign
1	Number of errors	8-bit hexadecimal ASCII	A total of 80 errors
2 to 81 (*1)	Error 1	8-bit hexadecimal ASCII	(*2)
			
	Error 80 (*1)	8-bit hexadecimal ASCII	

1: The maximum number of errors may vary depending on the software version of the MTP pump. It is recommended to design the tool software for variable-length data.

*2: After the corresponding error message has been sent. The most recent error corresponds to the largest parameter number. When the number of detected errors exceeds the maximum, the parameter values for the exceeding errors are set to 0.

Example: Error count: 02HEX = 2DEC: 2 errors

Error 1: 0DHEX = 13DEC: Perturbation AY

Error 2: 0FHEX = 15DEC: Perturbation BY

Error 3 to 80: 00HEX: No error detected

parameter	1	2	3	4	5	6	.....	79	80	81
ASCII	0	2	0	D	0	F		0	0	0
HEX	30	32	30	44	30	46		30	30	30

3.4.5 Read operation mode and real-time error information

Function: Read the pump's operating mode and detect real-time error messages. The detected error data is the same as the data from "reading real-time error messages".

Table31 Operation Mode

Operating mode	suspension	Not suspended	accelerate	normal operation	Deceleration (braking)	self-inspection	In the process of calibration	Calibration completed	System reservation
price	1	2	3	4	5	6	7	8	9, 10, 11

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	M	ETX	LRC	
								ACK

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	M	Parameters 1 to 82	ETX	LRC	ACK
-----	---	---	---	----	---	--------------------	-----	-----	-----

parameter	project	data format	sign
1	Operating mode	8-bit hexadecimal ASCII	refer to
2	Number of errors	8-bit hexadecimal ASCII	Up to 80 errors
3 to 82 (*1)	Error 1	8-bit hexadecimal ASCII	(*2)
			
	Error 80 (*1)	8-bit hexadecimal ASCII	

*1: The maximum number of errors may vary depending on the software version of the MTP pump. It is recommended to design the tool software to accommodate variable-length data.

*2: After the corresponding error messages have been sent, the most recent error corresponds to the largest parameter number. When the number of detected errors exceeds the maximum value, the parameter values for the exceeding errors are set to 0.

Example: Pump operation mode: 01HEX = 1DEC: Suspension

Error count: 02HEX = 2DEC: 2 errors

Error 1: 0DHEX = 13DEC: Perturbation AY

Error 2: 0FHEX = 15 DEC: Perturbation BY

Error 3 to 80: 00HEX: No error detected

parameter	1		2		3		4		5		6		.....	80		81		82	
ASCII	0	1	0	2	0	D	0	F	0	0	0	0		0	0	0	0	0	0
HEX	30	31	30	32	30	44	30	46	30	30	30	30		30	30	30	30	30	30

3.4.6 Read the target rotational speed and the set value of TMS target temperature

Function: Read the "target speed set value" and the TMS set temperature value. The "target speed set value" data is the same as the "read target speed set value" data.

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	d	ETX	LRC	
								ACK

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	d	Parameters 1 to 2	ETX	LRC	ACK
-----	---	---	---	----	---	-------------------	-----	-----	-----

parameter	project	data format	notes
1	Target rotational speed setpoint (unit: Hz)	16-bit hexadecimal ASCII	
2	TMS temperature set value (unit: °C)	16-bit hexadecimal ASCII	

Example: Target speed setting value: 01F4HEX = 500DEC: 500Hz (30000rpm)

TMS set temperature value: 0046HEX = 70DEC: 70°C

parameter	1				2			
ASCII	0	1	F	4	0	0	4	6
HEX	30	31	46	34	30	30	34	36

3.4.7 Read the temperature value of the motor

Function: Read motor temperature.

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	e	ETX	LRC	
								ACK

Host computer → MTP pump

MTP pump → host computer

									ACK
STX	0	0	1	SP	e	Parameter 1	ETX	LRC	

parameter	project	data format	notes
1	Motor temperature (unit: °C)	16-bit hexadecimal ASCII	

Example: Motor temperature: 0014HEX = 20DEC: 20°C

parameter	1			
ASCII	0	0	1	4
HEX	30	30	31	34

3.4.8 Read the settings of the control port, TMS, and emergency exhaust valve

Function: Read various settings (control port, TMS function, emergency exhaust valve, etc.).

Table32 Control Port

Control port	REMOTE	RS232/485 port (COM1)	RS485 port (COM2)	Monitor Port	System reservation
price	1	2	5	6	3, 4

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	f	ETX	LRC		
									ACK

Host computer → MTP pump

MTP pump → host computer

									ACK
STX	0	0	1	SP	f	Parameters 1 to 4	ETX	LRC	

parameter	project	data format	notes
1	Control port setting	Eight-bit hexadecimal ASCII	see
2	TMS function setting	Eight-bit hexadecimal ASCII	00HEX: Enabled; All others except 00HEX: Disabled
3	System reservation	Eight-bit hexadecimal ASCII	
4	Emergency exhaust valve setting	Eight-bit hexadecimal ASCII	00HEX: Enabled; all others except 00HEX: Disabled

Example: Control port setting: 01HEX: I/O REMOTE

TMS function setting: 00HEX: Enable

Emergency exhaust valve setting: FFHEX: Disabled

parameter	1		2		3		4	
ASCII	0	1	0	0	*1	*1	F	F
HEX	30	31	30	30			46	46

*1: System reservation

3.4.9 Set the target rotational speed setting value

Function: Changes the "target speed setpoint". The lower limit of the target speed setpoint is 50% of the rated speed. When the setpoint is less than the lower limit, the target speed is automatically set to the lower limit value; the upper limit of the target speed setpoint is the rated speed. When the setpoint is greater than the upper limit, the target speed value is automatically set to the upper limit value. The display effect of the "Run" indicator LED does not change with the change of the "target speed setpoint".

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	h	Parameter 1	ETX	LRC	
									ACK

Host computer → MTP pump

MTP pump → host computer

							ACK
STX	0	0	1	#	ETX	LRC	

parameter	project	data format	notes
1	Target rotational speed setpoint (unit: Hz)	16-bit hexadecimal ASCII code	

Example: Target speed setting value: 0190HEX= 400DEC: 400Hz (24000rpm)

parameter	1			
ASCII	0	1	9	0
HEX	30	31	39	30

3.4.10 Read the set value of target rotational speed

Function: Read the "Target Rotation Speed Setpoint". This value is identical to parameter 1 of "Read Target Rotation Speed and TMS Target Temperature Setpoint".

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	h	ETX	LRC	
								ACK

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	h	Parameter 1	ETX	LRC	ACK
-----	---	---	---	----	---	-------------	-----	-----	-----

parameter	project	data format	notes
1	Target rotational speed setpoint (unit: Hz)	16-bit hexadecimal ASCII code	

Example: Target speed setting value: 012CHEX = 300DEC: 300Hz (18000rpm)

parameter	1			
ASCII	0	1	2	C
HEX	30	31	32	43

3.4.11 Read operation mode, errors, and alarms

Function: Read operation mode, error, and alarm information. The relationship between alarm information and corresponding values is as follows: 表 33

Table33 Alarm Information

position	Alarm information	16-bit hexadecimal value
0	System reservation	0001
1	Warning: Level 2 damage limit	0002
2	Warning: Level 1 damage limit	0004
3	Alarm: Unbalanced AY	0008
4	Alarm: Unbalanced BY	0010
5	Warning: Unbalanced Z	0020
6	Alarm: Operation timeout	0040
7	Alarm: Overload	0080
8	System reservation	0100
9	System reservation	0200
10	System reservation	0400
11	System reservation	0800
12	System reservation	1000
13	System reservation	2000
14	System reservation	4000
15	System reservation	8000

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	m	ETX	LRC	
								ACK

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	m	Parameters 1 to 82	ETX	LRC	ACK
-----	---	---	---	----	---	--------------------	-----	-----	-----

parameter	project	data format	sign
1	Operating mode	8-bit hexadecimal ASCII code	see
2	give an alarm	16-bit hexadecimal ASCII code	see
3	Number of errors detected	8-bit hexadecimal ASCII code	Up to 79 errors
4-82 (*1)	Error 1	8-bit hexadecimal ASCII code	(*2)
	...		
	Error 79	8-bit hexadecimal ASCII code	

*1: The maximum number of errors may vary depending on the software version of the MTP pump. It is recommended to design the tool software to accommodate variable-length data.

*2: The most recent error corresponds to the maximum parameter value. When the number of detected errors exceeds the maximum, the parameter values for the exceeding errors are set to 0.

Example: Pump operation mode: 01HEX = 1DEC: Suspended

An alarm has been detected: 000CHEX = 0004 DEC (first-level damage limit) + 0008 DEC (imbalance AY)

Error count: 02HEX = 2DEC: 2 errors

Error 1: 0DHEX = 13DEC: Perturbation AY

Error 2: 0FHEX = 15DEC: Perturbation BY

Errors 3 to 79: 00HEX: No errors detected

parameter	1		2				3		4		5		6		.....	80		81		82	
ASCII	0	1	0	0	0	C	0	2	0	D	0	F	0	0		0	0	0	0	0	0
HEX	30	31	30	30	30	43	30	32	30	44	30	46	30	30		30	30	30	30	30	30

3.4.12 Read the current error record

Function: Read "Error Log". Read the last 10 errors detected.

Transmission frame:

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	g	ETX	LRC	
								ACK

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	Parameters 1 to 11	ETX	LRC	ACK
-----	---	---	---	----	--------------------	-----	-----	-----

parameter	project	data format	notes
1	The number of "error records"	8-bit hexadecimal ASCII	Up to 10 errors
2-11 (*1)	Error Record 1 to Error Record 10	8-bit hexadecimal ASCII	

*1: The most recent error corresponds to the smallest parameter value. When the number of detected errors exceeds the maximum, the parameter values of the exceeding errors are set to 0.

Example: When 3 historical errors are detected:

Number of error records: 03HEX = 3DEC: 3 errors

Error Record 1: 0FHEX = 15DEC: Perturbation BY

Error record 2: 0DHEX = 13DEC: Perturbation AY

Error Record 3: 12HEX = 18DEC: Motor Overheating

Error records 4 to 10: 00HEX: No error records

parameter	1		2		3		4		5		6		7		8		9		10		11	
ASCII	0	3	0	F	0	D	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEX	30	33	30	46	30	44	31	32	30	30	30	30	30	30	30	30	30	30	30	30	30	30

3.4.13 Read the status of TMS, motor, and controller

Function: Read TMS temperature, motor temperature, motor current, measure rotational speed, and controller temperature. The motor temperature value is the same as the value read by "Read Motor Temperature". The measured rotational speed value is the same as parameter 2 of "Read Real-time Rotational Speed" (measuring rotational speed).

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	[	ETX	LRC	ACK			
-----	---	---	---	---	---	-----	-----	-----	--	--	--

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	[	Parameters 1 to 9	ETX	LRC	ACK		
-----	---	---	---	----	---	-------------------	-----	-----	-----	--	--

parameter	project	data format	notes
1	System reservation	120-bit hexadecimal ASCII code	
2	TMS temperature (unit: °C)	16-bit hexadecimal ASCII code	
3	Motor temperature (unit: °C)	16-bit hexadecimal ASCII code	
4	System reservation	8-bit hexadecimal ASCII code	
5	Motor current (unit: 0.1A)	8-bit hexadecimal ASCII code	
6	System reservation	24-bit hexadecimal ASCII code	
7	Measure rotational speed (unit: Hz)	16-bit hexadecimal ASCII code	
8	System reservation	48-bit hexadecimal ASCII code	
9	Controller temperature (unit: °C)	16-bit hexadecimal ASCII code	

Example: TMS temperature: 0046HEX = 70DEC: 70°C (158 °F)

Motor temperature: 0014CHEX = 20DEC: 20°C (68 °F)

Motor current: 19HEX = 25DEC: 2.5A

Measured rotational speed: 01C2HEX = 450DEC: 450Hz (27,000rpm)

Controller temperature: 0032HEX = 50DEC: 50°C

parameter	1																	
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1
HEX																		

parameter	1													2			
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	0	0	4	6
HEX														30	30	34	36

parameter	3				4		5		6						7			
ASCII	0	0	1	4	*1	*1	1	9	*1	*1	*1	*1	*1	*1	0	1	C	2
HEX	30	30	31	34			31	39							30	31	43	32

parameter	8													9			
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	0	0	3	2
HEX														30	30	33	32

*1: System reservation

3.4.14 Read optional functions

Function: Read the settings of the control port (control port), alarm function, and communication timeout.

Table:34 Parameter Setting Values

parameter	project	data format
1	Setting of control port	REMOTE: 01HEX COM1 RS232/485: 02HEX COM2 RS485: 05HEX Monitoring port: 06HEX
2	Enable/disable setting of TMS function	00HEX: Enable; FFHEX: Disable
4	Enable/disable setting for secondary damage limit alarm	00HEX: enable; FFHEX: disable
5	Enable/disable setting for the first-level damage limit alarm	00HEX: Enable; FFHEX: Disable
6	Enable/disable setting for operation timeout alarm	00HEX: Enabled; FFHEX: Disabled
7	Time setting for operation timeout alarm	0 to 1000×100h (00000000HEX to 000003E8HEX), with a step size of 100h
8	Enabling/disabling of imbalance alarm	00HEX: Enabled; FFHEX: Disabled
9	Enable/disable setting for overload alarm	00HEX: Enabled; FFHEX: Disabled
10	Motor current setting for overload alarm	0 to 1000×0.1% (000HEX to 03E8HEX), with a step size of 0.1%
11	Rotational speed setting for overload alarm	0 to 1000×0.1% (000HEX to 03E8HEX), with a step size of 0.1%
12	Time setting for communication timeout alarm	0 to 30000 seconds (000HEX to 7530HEX), with a step size of 60 seconds, and 0 indicating the function is disabled

3.4.15 Set optional functions

Function: Change the settings for the control port, alarm function, and communication timeout.

Table:35 Parameter Setting Values

parameter	project	data format	notes
1	Setting of control port	8-bit hexadecimal ASCII code	Default 05HEX (COM2 RS485)
2	Enable/Disable setting of TMS option	8-bit hexadecimal ASCII code	Default FFHEX (disabled)
3	System reservation	48-bit hexadecimal ASCII code	(*1)
4	Enable/disable setting for secondary damage limit alarm	8-bit hexadecimal ASCII code	Default 00HEX (enabled)
5	Enable/disable setting for first-level damage limit alarm	8-bit hexadecimal ASCII code	Default 00HEX (enabled)
6	Enable/disable setting for operation timeout alarm	8-bit hexadecimal ASCII code	Default FFHEX (disabled)
7	Time setting for operation overtime alarm (×100 hours)	32-bit hexadecimal ASCII code	Default 00000000 HEX (enabled)
8	Unbalance alarm enable/disable setting	8-bit hexadecimal ASCII code	Default 00HEX (enabled)
9	Enable/disable setting of overload alarm	8-bit hexadecimal ASCII code	Default FFHEX (disabled)
10	Motor current setting for overload alarm	16-bit hexadecimal ASCII code	Default 03E8HEX (100.0%)
11	Rotational speed setting for overload alarm	16-bit hexadecimal ASCII code	Default 0000HEX (0.0%)
12	Time setting for communication timeout alarm (unit: sec)	16-bit hexadecimal ASCII code	Default 003CHEX (60 seconds)
13	System reservation	88-bit hexadecimal ASCII code	(*2)

*1: The set parameter values can be read and confirmed by using the command "Read Optional Functions (?=)" or "FFFF32003CFFHEX"

*2: The set parameter values can be read and confirmed through the command "Read Optional Functions (?=)" or "FHHEX"

For each parameter setting value, refer to Table 38 "Parameter Setting Values". When a parameter exceeds its set range, the value will be deemed invalid.

Transmission frame:

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	=	Parameters 1 to 13	ETX	LRC	
									ACK

Host computer → MTP pump

MTP pump → host computer

								ACK
STX	0	0	1	#	ETX	LRC		

Example: Control port setting: 01HEX: I/O REMOTE

TMS settings: FFHEX: disabled

Secondary damage limit alarm: 00HEX: enabled

First-level damage limit alarm: 00HEX: Enable

Operation timeout alarm: FFHEX: disabled

Time setting for operation timeout alarm: 00003E8HEX = 1000DEC: 1000 (×100 hours)

Unbalance alarm: 00HEX: Enable

Overload alarm: FFHEX: disabled

Motor current setting for overload alarm: 03E8HEX = 1000DEC: 1000 (×0.1%)

Rotational speed setting for overload alarm: 0000HEX = 0DEC: 0 (×0.1%)

Communication timeout setting: 003CHEX = 60DEC: 60 seconds

parameter	1		2		3												4		5	
ASCII	0	1	F	F	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	0	0	0	0
HEX	30	31	46	46													30	30	30	30

parameter	6		7									8	
ASCII	F	F	0	0	0	0	0	3	E	8	0	0	0
HEX	46	46	30	30	30	30	30	33	45	38	30	30	30

parameter	9		10				11				12				13					
ASCII	F	F	0	3	E	8	0	0	0	0	0	0	3	C	*2	*2	*2	*2	*2	*2
HEX	46	46	30	33	45	38	30	30	30	30	30	30	33	43						

parameter	13															
ASCII	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2
HEX																

*1: The set parameter values can be read and confirmed through the command "Read Optional Functions (?)" or "FFFF32003CFFHEX"

*2: The parameter values set can be read and confirmed through the command "Read Optional Functions (?)" or "FHEX"

3.4.16 Read the status of the molecular pump

Function: Read the model and damage points of the molecular pump.

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	{	ETX	LRC	
								ACK

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	{	Parameters 1 to 4	ETX	LRC	ACK
-----	---	---	---	----	---	-------------------	-----	-----	-----

parameter	project								data format				notes			
1	Molecular pump model								160-bit hexadecimal ASCII code							
2	System reservation								32-bit hexadecimal ASCII code							
3	Damage Point								16-bit hexadecimal ASCII code							
4	System reservation								64-bit hexadecimal ASCII code							

Example: Molecular pump model: 4D54502D3332303120202020202020202020HEX=MTP-3201

Damage point: 10HEX=16

parameter	1																			
	“M”		“T”		“P”		“ ”		“3”		“2”		0		“1”		“ ”		“ ”	
ASCII	4	D	5	4	5	0	2	D	3	3	3	2	3	0	3	1	2	0	2	0
HEX	34	44	35	34	35	30	32	44	33	33	33	32	33	30	33	31	32	30	32	30

parameter	1																			
	“ ”		“ ”		“ ”		“ ”		“ ”		“ ”		“ ”		“ ”		“ ”		“ ”	
ASCII	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0
HEX	32	30	32	30	32	30	32	30	32	30	32	30	32	30	32	30	32	30	32	30

parameter	2								3				4							
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	0	0	1	0	*1	*1	*1	*1	*1	*1	*1	*1
HEX									30	30	31	30								

3.4.17 Read historical error records

Function: Read historical "error records" with detection time.

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	}	ETX	LRC	
								ACK

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	}	Parameters 1 to 15	ETX	LRC	ACK
-----	---	---	---	----	---	--------------------	-----	-----	-----

Host computer → MTP pump

MTP pump → host computer

STX	0	0	2	Parameters 16 to 22	ETX	LRC	ACK
-----	---	---	---	---------------------	-----	-----	-----

parameter	project	data format	notes
1	The number of "error records"	8-bit hexadecimal ASCII code	
2	Maximum number of "error records"	8-bit hexadecimal ASCII code	
3-22	Error record 1 to error record 20	80-bit hexadecimal ASCII code (see "Error Record Format")	(*1)

*1: The closer the record, the smaller the parameter value.

Error record format: Depending on the model of the MTP pump, there are two formats for time recording:

- Total operation time of MTP pump and controller
- Real-time data with built-in clock

(—) When the time flag bit is set to 0:

parameter	project	data format	notes
a	error code	8-bit hexadecimal ASCII code	(*1)
b	time stamp	8-bit hexadecimal ASCII code	
c	Pump operation time	32-bit hexadecimal ASCII code	Unit: min
d	Controller operation time	32-bit hexadecimal ASCII code	Unit: min

*1: When the number of detected errors is below the maximum limit, parameter values greater than the number of detected errors will be set to FFHEX.

Example: When the pump has been running for 5000 minutes and the controller has been running for 6000 minutes, AY interference is detected:

parameter	a		b		c								d							
ASCII	0	D	0	0	0	0	0	0	1	3	8	8	0	0	0	0	1	7	7	0
HEX	30	44	30	30	30	30	30	30	31	33	38	38	30	30	30	30	31	37	37	30

(二) When the time flag bit is set to 1:

parameter	project	data format	notes
a	error code	8-bit hexadecimal ASCII code	(*1)
b	time stamp	8-bit hexadecimal ASCII code	
c	Error detection time (format: yymmddhhnn) yy: the last two digits of the year mm: month dd: day hh: Hour (24-hour format) nn: minute	40-bit hexadecimal ASCII code	(*2)
d	System reservation	24-bit hexadecimal ASCII code	

*1: When the number of detected errors is below the maximum value, set the parameter value greater than the number of detected errors to FFHEX.

*2: Each time value is transmitted as a string in BCD format.

Example: On September 13, 2007, at 12:34, an AY disturbance was detected

parameter	a		b		c								d							
ASCII	0	D	0	1	0	7	0	9	1	3	1	2	3	4	*3	*3	*3	*3	*3	*3
HEX	30	44	30	30	30	37	30	39	31	33	31	32	33	34						

*3: System reserved.

Example: When 3 historical errors are detected:

Error record number: 03HEX = 3DEC: 3 errors

Maximum number of error records: 14HEX = 20DEC: 20 errors

Error Record 1: Error Code 0FHEX (15DEC): Disturbance BY

Time stamp 01HEX: The detection time is the time recorded by the built-in clock

Error detection time 0709131234HEX: 12:34 on September 13, 2007

Error Record 2: Error Code 0DHEX (13DEC): Disturbance AY

Time stamp 01HEX: The detection time is the built-in clock time

Error detection time 0704300659HEX: 06:59, April 30, 2007

Error Record 3: Error Code 12HEX = 18DEC: Motor Overheating

Time stamp 01HEX: The detection time is the time indicated by the built-in clock

Error detection time 0612011508HEX: 15:08 on December 1, 2006

Error records 4 to 20: No errors recorded

parameter	1		2	
ASCII	0	3	1	4
HEX	30	33	31	34

parameter	3a		3b		3c								3d							
ASCII	0	F	0	1	0	7	0	9	1	3	1	2	3	4	*1	*1	*1	*1	*1	*1
HEX	30	46	30	31	30	37	30	39	31	33	31	32	33	34						

parameter	4a		4b		4c								4d							
ASCII	0	D	0	1	0	7	0	4	3	0	0	6	5	9	*1	*1	*1	*1	*1	*1
HEX	30	44	30	31	30	37	30	34	33	30	30	36	35	39						

parameter	5a		5b		5c								5d							
ASCII	0	F	0	1	0	6	1	2	0	1	1	5	0	8	*1	*1	*1	*1	*1	*1
HEX	30	46	30	31	30	36	31	32	30	31	31	35	30	38						

parameter	6a		6b		6c								6d							
ASCII	F	F	0	1	0	0	0	0	0	0	0	0	0	0	*1	*1	*1	*1	*1	*1
HEX	46	46	30	31	30	30	30	30	30	30	30	30	30	30						

parameter	7a		7b										21d					
ASCII	F	F	0	1	.....								*1	*1	*1	*1	*1	*1
HEX	46	46	30	31														

parameter	22a		22b		22c								22d							
ASCII	F	F	0	1	0	0	0	0	0	0	0	0	0	0	*1	*1	*1	*1	*1	*1
HEX	46	46	30	31	30	30	30	30	30	30	30	30	30	30						

*1: System reservation

3.4.18 Set the second speed function parameter

Function: Change the relevant settings for the second speed function.

Transmission frame:

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	0	Parameters 1 to n	ETX	LRC	
									ACK

Host computer → MTP pump

MTP pump → host computer

									ACK
STX	0	0	1	#	ETX	LRC			

parameter	project	data format	notes
1	Second speed function number	16-bit hexadecimal ASCII code	see Table 36
2 to n	functionality		

Table36 2: List of second speed function codes and parameters

project	price	Total parameter n	notes
Second speed option setting	0014	3	
Selection of the second speed target	0015	2	

(—) Second speed function setting

parameter	project	data format	notes
1	Second speed function number	16-bit hexadecimal ASCII code	0014HEX
2	Second rotational speed value setting (unit: Hz)	16-bit hexadecimal ASCII code	(*1)
3	Second speed enabling item	16-bit hexadecimal ASCII code	0000HEX: Disabled; 00FFHEX: Enabled

*1: The setting range for this value is between 50% and 100% of the rated speed value. When the parameter value exceeds 100% of the rated speed value, it will automatically be set to the rated speed value. When the parameter value is less than 50% of the rated speed value, it will automatically be set to 50% of the rated speed value.

Example: Second speed value setting: 00E1HEX = 225DEC: 225Hz (13500rpm)

Second speed enable item: 0000HEX: disabled

parameter	1				2				3			
ASCII	0	0	1	4	0	0	E	1	0	0	0	0
HEX	30	30	31	34	30	30	45	31	30	30	30	30

(二) Selection of the second speed target

In the normal operating state, the second speed target can be selected as either the target rotational speed value or the second rotational speed value. When using this function, the "Second Speed Enable" option needs to be set to "Enabled".

parameter	project	data format	notes
1	Second speed function number	16-bit hexadecimal ASCII code	0015HEX
2	Selection of the second speed target	16-bit hexadecimal ASCII code	0000HEX: Target Rotation Speed Value 0001HEX: Second Rotation Speed Value

Example: Second speed target selection: 0000HEX: Target rotational speed value

parameter	1				2			
ASCII	0	0	1	5	0	0	0	0
HEX	30	30	31	35	30	30	30	30

3.4.19 Read the second speed functional parameter

Function: Read the setting value of the second speed function. The parameter n depends on the optional function.

Table37 2: List of Function Numbers and Parameters for the Second Rotation Speed

project	price	Total parameter n	notes
Second speed function setting	0014	4	see
Selection of the second speed target	0015	2	see

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	?	0	Parameter 1	ETX	LRC	
									ACK

Host computer → MTP pump

MTP pump → host computer

STX	0	0	1	SP	0	Parameters 1 to n	ETX	LRC	
									ACK

parameter	project	data format	notes
1	Second speed function number (send/return)	16-bit hexadecimal ASCII code	see
2 to n	Function item (return)		

(一) Second speed function setting

The second speed function can be set according to the following table:

parameter	project	data format	notes
1	Second speed function number	16-bit hexadecimal ASCII code	0014HEX
2	Second rotational speed value setting (unit: Hz)	16-bit hexadecimal ASCII code	
3	Second speed enabling item	16-bit hexadecimal ASCII code	0000HEX: Disabled; 00FFHEX: Enabled
4	Second speed target value (unit: Hz)	16-bit hexadecimal ASCII code	

Example: Second speed value setting: 00E1HEX = 225DEC: 225Hz (13500rpm)

Second speed enable item: 0000HEX: disabled

Second speed target value: 01C2HEX = 450DEC: 450Hz (27000rpm) (target speed value)

parameter	1				2				3				4			
ASCII	0	0	1	4	0	0	E	1	0	0	0	0	0	1	C	2
HEX	30	30	31	34	30	30	45	31	30	30	30	30	30	31	43	32

(二) Selection of the second speed target

Under normal operating conditions, the speed target for the second speed can be directly read.

parameter	project	data format	notes
1	Second speed function number	16-bit hexadecimal ASCII code	0015HEX
2	Second speed target	16-bit hexadecimal ASCII code	0000HEX: Target Rotation Speed Value 0001HEX: Second Rotation Speed Value

Example: Second speed target: 0000HEX: target rotational speed value

parameter	1				2			
ASCII	0	0	1	5	0	0	0	0
HEX	30	30	31	35	30	30	30	30

4 PROFIBUS communication protocol (optional)

4.1 Introduction to PROFIBUS Communication

4.1.1 overview

The MTP series magnetic levitation molecular pumps (hereinafter referred to as MTP pumps) are equipped with a PROFIBUS interface that supports connection to a PROFIBUS-DP network. It complies with the EN50170 standard and can only be accessed by V0 PROFIBUS devices.

When using PROFIBUS control commands, the MTP pump control port needs to be set to "RS485 interface", otherwise PROFIBUS only has query functionality.

When utilizing the PROFIBUS functionality, it is necessary to use the GSD file "MTP1815.GSD" provided by Zhongke Jiuwei, and configure the system with an ID number of 0x1815.

Note: The GSD file "MTP1815.GSD" provided by Zhongke Jiuwei must be used. If the GSD file is incorrect, the PROFIBUS communication function cannot be utilized.

4.1.2 Setting Steps

- (一) Connect to the "RS485" connector using a 9-pin "D" type PROFIBUS connector;
- (二) Download the "MTP1815.GSD" file to the PROFIBUS master station;
- (三) Select the mode "Mod01 Pump Command, 1 Out", which enables the start, stop, and reset operations of the pump;
- (四) Turn on the power "switch" button of the MTP pump;
- (五) Set the PROFIBUS master station to send operation commands: 0x01, start; 0x02, stop.

4.1.3 PROFIBUS terminal

The PROFIBUS interface of the MTP pump is not equipped with a terminal, but it needs to be connected as per the standard PROFIBUS-DP bus when in use. Terminals should be added at both ends of the PROFIBUS bus, and standard terminal resistors need to be selected.

4.1.4 Baud rate setting

The PROFIBUS communication of the MTP pump supports 10 standard DP baud rates, which are: 9.6 kbd, 19.2 kbd, 45.45 kbd, 93.75 kbd, 187.5 kbd, 500 kbd, 1.5 Mbd, 3 Mbd, 6 Mbd, and 12 Mbd. The MTP pump does not have a device to adjust the baud rate; it automatically detects and responds to the baud rate selected by the master station.

4.1.5 Connection method

Connect to the "RS485" port on the front panel of the controller using a PROFIBUS-DP cable, where pin 3 of the "RS485" port is "D-" and pin 8 is "D+", as a reference 3.2.1. If using the PROFIBUS communication function of the MTP pump, the MTP pump operation port needs to be selected as the RS485 port, and the RS485 port should be set to its default settings.

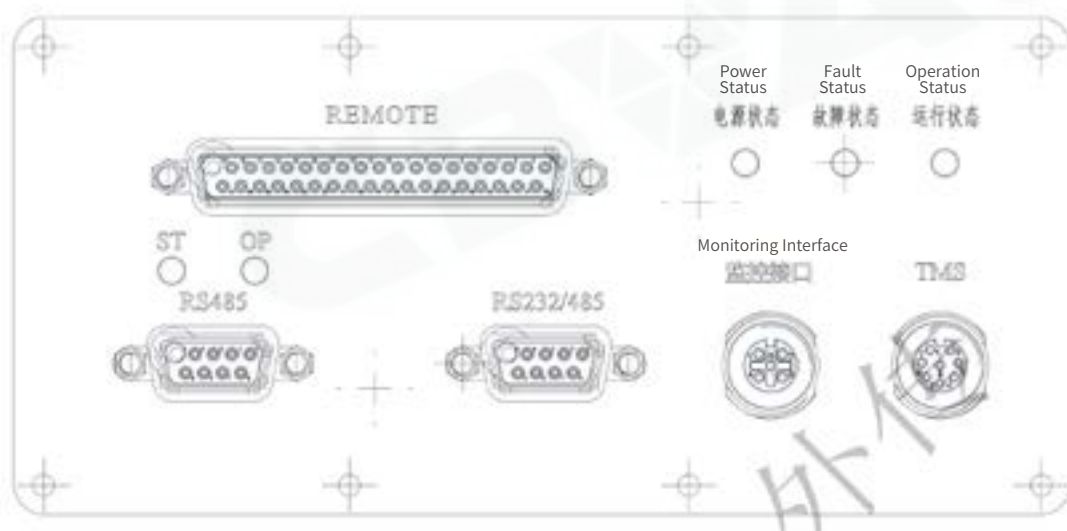


Figure 48 Model diagram of PROFIBUS front interface board

4.1.6 PROFIBUS indicator light

Table: 38 Explanation of PROFIBUS indicator lights

name	state	function
OP	close	No power supply/offline
	Green constant light	Online, data exchange
	Green flashing	on line
	Blinks red once	Parameter setting error
	Blinks red twice	PROFIBUS configuration error
ST	close	not initialized
	Green constant light	initialization
	Green flashing	Initialization, diagnostic event exists
	Red light constantly on	exception error

4.1.7 PROFIBUS address

The PROFIBUS address is stored in the MTP pump, with an initial setting of 4 and a usage range of [2, 125]. If modifications are required, please contact the after-sales service of Zhongke Jiuwei for assistance.

4.2 Software format

The PROFIBUS device software is based on a modular and configurable architecture, thus allowing users considerable control over the content of data exchange messages. Software modules are defined in GSD files.

When the unit is connected to PROFIBUS, it will be configured and can be parameterized before entering data exchange. The parameterization and configuration options are in the GSD file, with comments describing the data content of inputs, outputs, and parameterization bytes.

When transmitting sixteen-bit numbers, the MSB (most significant eight bits) is sent first, followed by the LSB (least significant eight bits).

4.3 Software block

Overall table of components

piece	Block description	Output Bits	Input Bits	Parameter bit count
01	MTP pump command	1		
02	MTP pump status		1	
03	Warning message		2	
04	fault information		16	
05	Current operating speed		2	
06	motor current		1	
07	motor temperature		2	
08	Control unit temperature		2	
09	System reservation			
10	System reservation			
11	System reservation			
12	System reservation			
13	System reservation			
14	System reservation			
15	System reservation			
16	System reservation			
17	System reservation			
18	Target rotational speed setpoint		2	4
19	System reservation			
20	System reservation			
21	System reservation			
22	Set the target rotational speed	2	2	

Note: The reserved part of the system is for internal testing purposes.

4.3.1 Block 01: MTP Pump Command

(一) block identifier

"Mod01 Pump Command, 1 Out"

(二) Description: The control block of the MTP pump is used to initiate, terminate, and reset the MTP pump.

(三) Output (for the main station)

position	price	function
1	0x01	start
	0x02	stop
	0x04	reset

(四) Input (for the main station)
not have

4.3.2 Block 02: MTP Pump Status

(一) block identifier

"Mod02 Pump State, 1 In"

(二) Description: Inquire about the operational status of the MTP pump.

(三) Output (for the main station)

(四) Input (for the main station)

position	price	function
1	0x01	suspension
	0x02	Not suspended
	0x03	accelerate
	0x04	normal operation
	0x05	Deceleration (braking)
	0x06	self-inspection
	0x07	In the process of calibration
	0x08	Calibration completed

4.3.3 Block 03: Warning Information

(一) block identifier

"Mod03 Warning flags, 2 In"

(二) Description: Querying the warning information of the MTP pump. The parameter consists of 2 bytes, with the high-order byte preceding the low-order byte. It contains a total of 16 flag bits, each representing a specific type of warning information.

(三) Output (for the main station)

(四) Input (for the main station)

position	price	information	price	information
1&2	Bit0	System reservation	Bit8	System reservation
	Bit1	Warning: Level 2 damage limit	Bit9	System reservation
	Bit2	Warning: Level 1 damage limit	Bit10	System reservation
	Bit3	Alarm: Unbalanced AY	Bit11	System reservation
	Bit4	Alarm: Unbalanced BY	Bit12	System reservation
	Bit5	Alarm: Unbalanced Z	Bit13	System reservation
	Bit6	Warning: Operation timeout	Bit14	System reservation
	Bit7	Warning: Overload	Bit15	System reservation

4.3.4 Block 04: Fault Information

(一) block identifier

"Mod04 Failure flags, 16 In"

(二) Description: Querying fault information of the MTP pump. Each byte contains 8 flag bits, with each bit representing a specific type of fault information.

(三) Output (for the main station)

(四) Input (for the main station)

position	price	information	price	information
1	Bit0	RAM error	Bit4	TMS overheating 2
	Bit1	EEPROM error	Bit5	Abnormal power loss of external power supply
	Bit2	TMS overheating 1	Bit6	Power Failure
	Bit3	TMS circuit breaker is open	Bit7	Overspeed 1
2	Bit0	Motor drive overvoltage	Bit4	Motor drive overload
	Bit1	System reservation	Bit5	Disturbance AY
	Bit2	Overheating inside the controller component 1	Bit6	Disturbance AX
	Bit3	Motor drive overcurrent	Bit7	Disturbance BY
3	Bit0	Disturbance BX	Bit4	Internal overheating of controller components 2
	Bit1	Disturbance Z	Bit5	System reservation
	Bit2	motor overheating	Bit6	System reservation
	Bit3	System reservation	Bit7	System reservation
4	Bit0	Motor drive communication failure	Bit4	Loss of speed detection signal
	Bit1	First-level damage limit alarm	Bit5	Overspeed 2
	Bit2	Secondary damage limit	Bit6	Overspeed 3
	Bit3	Not allowed to start	Bit7	Loss of motor temperature detection signal
5	Bit0	TMS temperature is too low	Bit4	System reservation
	Bit1	AMB communication failure	Bit5	System reservation
	Bit2	System reservation	Bit6	System reservation
	Bit3	Loss of TMS detection signal	Bit7	System reservation
6	Bit0	System reservation	Bit4	Alarm: Unbalanced BY
	Bit1	System reservation	Bit5	Alarm: Unbalanced Z
	Bit2	System reservation	Bit6	System reservation
	Bit3	Alarm: Unbalanced AY	Bit7	System reservation
7	Bit0	System reservation	Bit4	Abnormal motor identification resistance
	Bit1	System reservation	Bit5	Drive current fault
	Bit2	Motor drive failure	Bit6	Cooling fan failure
	Bit3	System reservation	Bit7	Drive CPU failure
8	Bit0	System reservation	Bit4	System reservation
	Bit1	Overcurrent of magnetic bearing	Bit5	System reservation
	Bit2	DSP initialization failed	Bit6	System reservation
	Bit3	Acceleration fault	Bit7	System reservation
9	Bit0	System reservation	Bit4	System reservation
	Bit1	System reservation	Bit5	System reservation
	Bit2	System reservation	Bit6	System reservation
	Bit3	System reservation	Bit7	System reservation
10	Bit0	Abnormal braking	Bit4	Magnetic bearing overcurrent
	Bit1	Abnormal acceleration	Bit5	fan failure
	Bit2	TMS voltage mismatch	Bit6	Serial communication timeout
	Bit3	under voltage	Bit7	System reservation
11	Bit0	System reservation	Bit4	System reservation
	Bit1	System reservation	Bit5	System reservation
	Bit2	System reservation	Bit6	System reservation
	Bit3	System reservation	Bit7	System reservation
12	Bit0	Overspeed 4	Bit4	System reservation
	Bit1	System reservation	Bit5	System reservation
	Bit2	The controller component is experiencing internal overheating3	Bit6	System reservation
	Bit3	System reservation	Bit7	System reservation
13 to 16	System reservation			

4.3.5 Block 05: Current operating speed

(一) block identifier

"Mod05 Pump Speed, 2 In"

(二) Description: Query the current operating speed of the MTP pump, with the high-order value preceding the low-order value. The queried value is the actual current operating speed, with the unit being Hz.

(三) Output (for the main station)

(四) Input (for the main station)

position	price	information
1&2	16-bit unsigned integer	Current rotational speed (Hz)

4.3.6 Block 06: Motor current

(一) block identifier

Module = "Mod06 Motor Current, 1 In"

(二) Description: Query the current of the MTP pump motor. The value queried is one-tenth of the actual motor current, measured in amperes (A).

(三) Output (for the main station)

(四) Input (for the main station)

position	price	information
1	8-bit unsigned number	Motor current = this value * 10, (A)

4.3.7 Block 07: Motor Temperature

(一) block identifier

Module = "Mod07 Motor Temp, 2 In"

(二) Description: Query the temperature of the MTP pump motor, with the high-order value preceding the low-order value. The queried value represents the actual motor temperature, measured in degrees Celsius.

(三) Output (for the main station)

(四) Input (for the main station)

position	price	information
1&2	16-bit signed integer	Motor temperature (°C)

4.3.8 Block 08: Control Unit Temperature

(一) block identifier

Module = "Mod08 Cont Temp, 2 In"

(二) Description: Query the temperature of the MTP pump control unit, with the high-order value preceding the low-order value. The queried value is the actual temperature of the control unit, measured in degrees Celsius.

(三) Output (for the main station)

(四) Input (for the main station)

position	price	information
1&2	16-bit signed integer	Control unit temperature (°C)

4.3.9 Block 18: Read target rotational speed

(一) block identifier

Module = "Mod18 Speed setpoint, 2 In "

(二) Description: Query the target rotational speed of the MTP pump, with the high-order value preceding the low-order value. The queried value represents the actual target rotational speed, with the unit being Hz.

(三) Output (for the main station)

(四) Input (for the main station)

position	price	information
1&2	0x00, 0x12	Representative block 18
3&4	16-bit unsigned integer	Target rotational speed (Hz)

4.3.10 Block 22: Set target rotational speed

(一) block identifier

Module = "Mod22 Speed demand, 2 out "

(二) Description: Set the target rotational speed of the MTP pump, with the unit being Hz. The set target rotational speed value should comply with the allowable operating speed range of the MTP pump.

(三) Output (for the main station)

position	price	information
1&2	16-bit unsigned integer	Set target rotational speed (Hz)

(四) Input (for the main station)

position	price	information
1&2	16-bit unsigned integer	Effective target rotational speed (Hz)

5 EtherCAT communication protocol (optional)

5.1 Introduction to EtherCAT communication function of MTP pump

This chapter elaborates on the installation, operation, and maintenance methods for the EtherCAT communication function selected for the MTP pump. Users must read this chapter before installing, operating, or maintaining the EtherCAT communication function. Additionally, users must follow the EtherCAT interface specified in this manual, otherwise it may cause damage to the equipment. Zhongke Jiuwei is not responsible for any damage or injury caused by improper use of the equipment.

The EtherCAT interface of the MTP pump is integrated onto the front interface panel of the MTP pump, utilizing a standard RJ45 connector and being compatible with Fast Ethernet 100Base-TX. The EtherCAT interface of the MTP pump serves as a gateway between the EtherCAT protocol and the ASCII serial protocol based on RS485, enabling remote control through the EtherCAT network. Upon turning on the main power switch of the MTP pump, the EtherCAT interface starts directly. 图 49 Taking the MTP-2201CTES (ISO250F) as an example, the appearance of the EtherCAT version of the MTP pump is displayed.

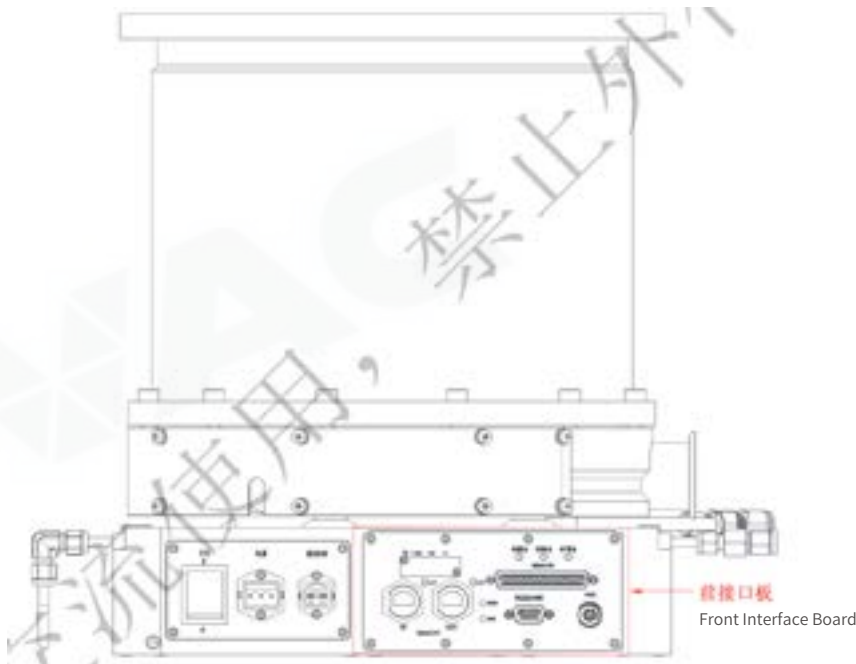


Figure49 Front view of MTP pump front interface board (EtherCAT version) (taking MTP-2201CTES(ISO250F) as an example)

5.2 Instructions for the EtherCAT version of the MTP pump

5.2.1 Unpacking

Check whether the outer packaging is damaged, whether the shipping order matches the purchase order, and whether the shipping list matches the actual items.

Before installing, operating, or maintaining the EtherCAT interface module, users must first read this manual.

Note: The EtherCAT interface module is integrated into the controller of the MTP pump.

Note: It is recommended that users retain the original packaging materials for reuse during transportation, storage, and other operations. If there are any quality issues with the product, please contact Zhongke Jiuwei and return it in its original packaging.

5.2.2 Electrical connection of front interface panel

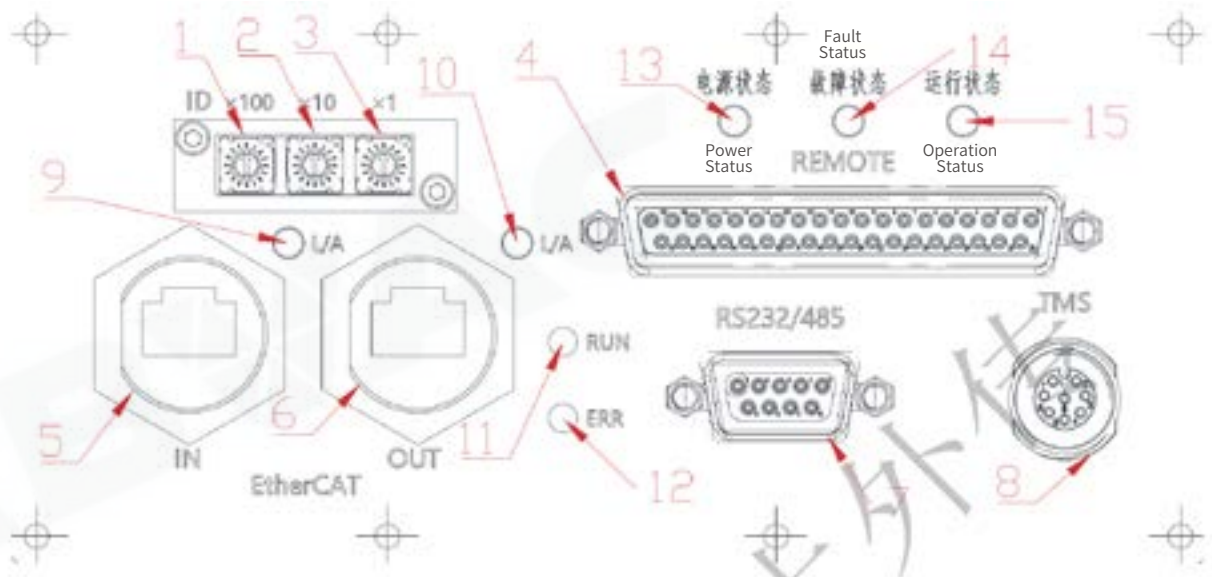


Figure 50 Schematic diagram of the front interface panel of the MTP pump in the EtherCAT version
Table40 Summary of descriptions for each part of the MTP pump's front interface panel in the pre-EtherCAT version

Serial Number	name	notes
1	ID address rotary encoder × 100	EtherCAT communication ID address rotary encoding, which consists of three rotary encodings that collectively form the EtherCAT communication ID.
2	ID address rotary encoder × 10	
3	ID address rotary encoder × 1	
4	REMOTE interface	Control or view the status of the MTP pump through node-based methods.
5	EtherCAT communication IN interface	See 5.2.3Section for details.
6	EtherCAT communication OUT interface	
7	RS232/485 interface	Communication with the MTP pump can be achieved via RS232 or RS485.
8	TMS interface	Used when the TMS function is selected.
9	EtherCAT communication IN interface indicator light	See the section for 5.2.5details.
10	EtherCAT communication OUT interface indicator light	
11	EtherCAT communication RUN status indicator	
12	EtherCAT communication OUT status indicator	
13	MTP pump power status indicator light	See 2.4Section for details
14	MTP pump fault status indicator	
15	MTP pump operation status indicator	

5.2.3 EtherCAT communication IN and OUT interfaces

Connect the MTP pump to the EtherCAT communication network through the IN and OUT interfaces of EtherCAT. During the networking process, the IN interface of the MTP pump must be connected to the previous slave device in the network (closer to the master device), and the OUT interface must be connected to the next slave device in the network (further from the master device). When the MTP pump is located at the end of the daisy chain network, the OUT interface can be left unconnected.

It is recommended to use shielded and twisted patch cables compliant with the 100 BASE-TX standard to achieve optimal electromagnetic compatibility.

Pin	describe
1	Send data +
2	Sending data -
3	Receive data +
4	not connected
5	not connected
6	Receive data -
7	not connected
8	not connected

5.2.4 Communication parameter setting of MTP pump

The EtherCAT interface of the MTP pump is integrated onto the MTP pump, serving as a gateway between the EtherCAT protocol and the ASCII serial protocol based on COM2 RS485, enabling remote control through the EtherCAT network. Therefore, before the MTP pump leaves the factory, the relevant items of the MTP pump's COM2 RS485 communication parameters are set to default values, as shown in 表 42.

Table:42 Parameter settings for MTP pump when using EtherCAT communication function

parameter		set value
communication parameters	Baud rate	9600 bps
	Bit length	8 bit
	stop bit	1 bit
	check bit	None
	Drive	RS485 single unit
	RS485 ID	1

5.2.5 EtherCAT communication indicator light

The indicator lights for the EtherCAT interface comply with the EtherCAT standard and consist of one IN interface indicator light, one OUT interface indicator light, one RUN status indicator light, and one OUT status indicator light. 表 43The status and meanings represented by each indicator light for EtherCAT communication are detailed.

Table: 43Description of EtherCAT Communication Indicators

Indicator light (color)	mode	meaning
IN interface indicator light (green)	Extinguish	Power-off state or no network connection established
	Green constant light	Establish network connection, no data transmission
	Green flash	Establish a network connection for data transmission
OUT interface indicator light (green)	Extinguish	Power-off state or not connected
	Green constant light	Connection successful, no data transmission
	Green flash	Connection successful and data transmission established
RUN status indicator light (green/red)	Extinguish	The EtherCAT interface is in a powered-off state or in an initialization state
	Green constant light	The EtherCAT interface is in operation
	Green slow flashing	The EtherCAT interface is in a pre-operational state
	Green single flash	The EtherCAT interface is in a safe operating state
	Green flash	The EtherCAT interface is in the startup state
	Steady red light	If both the RUN status indicator and the ERR status indicator turn red, it indicates that a fatal event has occurred, causing the bus interface to enter a physically passive state. Please contact our technical support team
ERR status indicator light (red)	Extinguish	Power-off state or no error
	Slow flashing in red	Due to invalid configuration, the EtherCAT interface cannot receive status change information from the host
	Single red flash	An unsolicited state change occurred in the EtherCAT interface
	Two flashes in red	Synchronization manager watchdog timeout
	Red constant light	If both the RUN status indicator and the ERR status indicator turn red, it indicates that a fatal event has occurred, causing the bus interface to enter a physically passive state. Please contact our technical support team
	Red flash	An error occurred during the startup process of the EtherCAT interface

5.2.6 EtherCAT communication ID rotary encoder

The EtherCAT communication ID is determined by the three ID rotary encoders on the front interface panel, which can be adjusted by the operator using a small screwdriver or potentiometer adjustment tool. The ID number is represented in hexadecimal, and each ID rotary encoder has 16 positions ranging from 0HEX to FHEX. The hexadecimal ID numbers represented by the three ID rotary encoders are:

EtherCAT communication ID number = (ID address rotary code $\times$ 100) * 100 HEX + (ID address rotary code $\times$ 10) * 10 HEX + (ID address rotary code $\times$ 1) * 1 HEX

There are a total of 000HEX to FFFFHEX EtherCAT communication ID addresses. The EtherCAT communication ID number of the MTP pump is the unique address identifier in the EtherCAT network.

5.2.7 MTP pump operation port

When using the EtherCAT version of the MTP pump with the EtherCAT communication port for control, the control port of the MTP pump must be set to COM2 RS485. Otherwise, the EtherCAT communication port only has the function of querying status.

5.3 MTP pump EtherCAT communication

5.3.1 Slave device description file

Zhongke Jiuwei equips the EtherCAT version of the MTP pump with a slave description file ESI (EtherCAT Slave Information): MTPEtherCatSerialFull.xml. This file contains manufacturer information and slave description information.

5.3.2 Instruction Description

For detailed instructions on the EtherCAT communication commands of the MTP pump, please refer to

Table: 44Detailed Description of EtherCAT Communication Commands for MTP Pumps

index	Sub-Index	data type	B/S	SDO Access	PDO Rx/Tx	default value	minimum value	Maximum value	name	describe
0x6000									MTP pump status and sensor values	SDP
	0x01	BOOL		RO	Tx	0			Flag: Suspended state	1: Suspended state; 0: Not suspended
	0x02	BOOL		RO	Tx	0			Mark: Non-levitated state	1: Not levitated; 0: Not
	0x03	BOOL		RO	Tx	0			Flag: Acceleration state	1: Accelerating state; 0: Not in accelerating state
	0x04	BOOL		RO	Tx	0			Indicator: Normal operating state	1: Normal operating state; 0: Not normal
	0x05	BOOL		RO	Tx	0			Indicator: Deceleration state	1: Deceleration state; 0: Not applicable
	0x06	BOOL		RO	Tx	0			Indicator: Self-checking status	1: Self-checking status; 0: Not applicable
	0x07	BOOL		RO	Tx	0			Indicator: Calibration Status	1: Calibration status; 0: Not applicable
	0x08	BOOL		RO	Tx	0			Indicator: Calibration completion status	1: Calibration completed; 0: Not completed
	0x09	BOOL		RO	Tx	0			Mark: Second Rotation Speed Mode	1: Second speed mode state; 0: Not applicable
	0x0A	UINT		RO	Tx	0			Motor speed (Hz)	Ratio - 1[Hz]
	0x0B	UINT		RO	Tx	0			Motor current (A)	Ratio - 0.1[A]
	0x0C	INT		RO	Tx				motor temperature	Ratio - 1[°C]
	0x0D	INT		RO	Tx				Control unit temperature	Ratio - 1[°C]
	0x0E	UINT		RO	Tx				Second rotational speed target set value (Hz)	Ratio - 1[Hz]
	0x0F	UINT		RO	Tx				Target rotational speed setting value (Hz)	Ratio - 1[Hz]

0x8001									MTP pump parameter setting	SDP
	0x02	UINT	B/S	RW	Rx				Setting: Second rotational speed target set value	Ratio - 1[Hz]. The setting range for this value is 50% to 100% of the rated speed value. When the parameter value exceeds 100% of the rated speed value, it will automatically be set to the rated speed value. When the parameter value is less than 50% of the rated speed value, it will automatically be set to 50% of the rated speed value.
	0x03	UINT	B/S	RW	Rx				Setting: Target rotational speed	Ratio - 1[Hz]. The setting range for this value is between 50% and 100% of the rated speed value. When the parameter value exceeds 100% of the rated speed value, it will automatically be set to the rated speed value. When the parameter value is less than 50% of the rated speed value, it will automatically be set to 50% of the rated speed value.
0xF381									MTP pump alarm status	
	0x01	UINT32		RO	Tx	0				Real-time feedback of the alarm status of the MTP pump. For each bit: 1: Occurred; 0: Normal . Bit0: System reserved . Bit1: Secondary damage limit . Bit2: Primary damage limit . Bit3: Unbalance AY . Bit4: Unbalance BY bit5: Unbalance Z bit6: MTP Pump Operation Timeout bit7: Overload bit8~15: System Reserved
0xF383									MTP pump fault state 0	
	0x01	UINT32		RO	Tx	0				The bit representation of MTP pump fault information, where each bit number represents a fault code, and each bit value: 1: occurred; 0: not occurred.
0xF384									MTP pump fault state 1	ss
	0x01	UINT32		RO	Tx	0				The bit representation of MTP pump fault information, where each bit number +32 represents a fault code, and each bit value: 1: occurred; 0: not occurred.
0xF385									MTP pump fault state 2	
	0x01	UINT32		RO	Tx	0				The bit representation of MTP pump fault information, where each bit number +64 represents a fault code, and each bit value: 1: occurred; 0: not occurred.

6 Protection function

The MTP pump has comprehensive detection and protection functions for various faults or anomalies. When multiple alarms or faults are detected simultaneously, it indicates high priority and outputs an alarm or fault signal through the "REMOTE" connector. If the MTP pump triggers a protection function, please investigate according to the prompts of the fault or alarm. If the fault cannot be identified or the MTP pump still fails to work properly after troubleshooting, please contact after-sales service in a timely manner.

6.1 Protection function

Note: The "Fault Indication LED" uses a red flashing pattern to indicate the type of fault.

6.1.1 Abnormal power loss of external power supply

When the external power supply experiences an abnormal power loss or other malfunctions, resulting in a voltage drop below 160V, the magnetic bearing will maintain its normal levitation state by utilizing the feedback energy generated by the permanent magnet motor, provided that the MTP pump maintains a certain rotational speed (self-protection during abnormal power loss of the external power supply).

The minimum rotational speed at which the magnetic bearing can operate normally during an abnormal power loss of the external power supply is referred to as the rotor drop-out speed.

(一) When an abnormal power loss occurs to the external power supply at a rotational speed close to 5000 rpm or higher:

When the MTP pump detects an abnormal power loss from the external power supply for 2 seconds or longer, it will automatically slow down. At this time, the "Power Status Indicator" will turn off and the "Fault Status Indicator (red)" will light up. Simultaneously, the "Power Output" pins 9 and 28 of the "REMOTE" connector will be disconnected, and the fault signal will be output from the "Fault Output" pins 14 and 33.

When the rotational speed drops to approximately 5000 rpm, the rotor lands on the protective bearing and gradually comes to a halt. At this point, all LED lights turn off.

When the external power supply experiences an abnormal power loss lasting less than 2 seconds, the MTP pump will maintain normal operation.

(二) When an abnormal power loss occurs to the external power supply at a rotational speed below 5000rpm:

The rotor of the MTP (Magnetic Suspension Molecular Pump) lands on the protective bearing and gradually comes to a halt.

The following table shows the status of the indicator lights and the output signal of REMOTE during abnormal power loss of the external power supply.

Table45 Status of the status indicator and REMOTE output signal during abnormal power loss of the external power supply

rotational speed	Power-off duration	LED		Remote output data (REMOTE control)		
		power supply	fault	Power status		
						N.C.
≥ 5000rpm	≥ 2s	Extinguish	light up	break	short circuit	break
	< 2s	normal operation				
< 5000rpm		Extinguish	Extinguish	break	break	short circuit

6.1.2 Power off and then restart

1. When an external power supply experiences an abnormal power loss and automatically resets while the MTP pump continues to decelerate:

The "Power Status Indicator" is lit and the "Fault Status Indicator" is off. The "Power Output" pins 9 and 28 of the "REMOTE" connector are closed, and the fault signals indicated by "Fault Output" pins 14, 33, and 15, 33 are reset.

2. When the power supply is restored and the "start" signal is input, the MTP pump begins to accelerate again.

After the rotor lands on the protective bearing, the power supply is restored: the controller may detect excessive vibration and trigger protection, and the MTP pump can only be restarted after the fault is reset.

6.1.3 Magnetic bearing anomaly

When abnormalities such as cable breakage or connector damage prevent the magnetic bearing from functioning properly, the rotor will automatically land on the protective bearing and gradually come to a halt. At this time, the "Fault Status Indicator (red)" flashes, and the "REMOTE" connector outputs a fault signal.

6.1.4 Excessive vibration (disturbance)

When severe external shock vibration causes the rotor of the MTP pump to contact the protective bearing, it will trigger automatic protection deceleration and shutdown. At this time, the "Fault Status Indicator (red)" flashes, and the "REMOTE" connector outputs a fault signal.

Note: Noise will be generated when the high-speed rotor comes into contact with the protective bearing.

6.1.5 Motor drive overload

If the MTP pump fails to reach the set speed within 30 minutes after startup, it will trigger an overload fault and automatically slow down and shut down.

At this time, the "Fault Status Indicator (red)" flashes, and the "REMOTE" connector outputs a fault signal.

6.1.6 The MTP pump is internally overheated (motor overheating)

When the temperature of the internal motor of the MTP pump exceeds safe limits, it will trigger overheat protection, automatically slowing down and stopping the pump. At this time, the "Fault Status Indicator (red)" will flash, and the "REMOTE" connector will output a fault signal.

6.1.7 Internal overheating of the controller

When the temperature inside the controller rises due to abnormal cooling water flow or temperature, excessively high ambient temperature, cooling fan failure, or other abnormalities, the MTP pump will trigger overheat protection and slow down to a halt. At this time, the "Fault Status Indicator (red)" flashes, and the "REMOTE" connector outputs a fault signal.

6.1.8 speeding

When the MTP (Magnetic Suspension Molecular Pump) loses control and its speed exceeds the set threshold, it will trigger the overspeed protection and automatically shut down freely. At this time, the "Fault Status Indicator (red)" flashes, and the "REMOTE" connector outputs a fault signal.

Table:46 MTP Pump Overspeed Threshold Table

Pump model	Rated speed rpm	Overspeed threshold rpm
MTP-1601	36540	38000
MTP-2201	27000	29000
MTP-3201	27720	29000
MTP-4301	24240	25700

6.1.9 Failure of TMS function (optional)

When there is an abnormality in the TMS-assisted heating, it can lead to uncontrolled temperature of the pump body.

When the temperature of the pump body exceeds the set value by 10 ° C, it will trigger the TMS overheat protection, execute the deceleration shutdown command, automatically shut off the auxiliary heating, and simultaneously open the TMS cooling water valve. At the same time, the "Fault Status Indicator (red)" will light up, and the REMOTE port will output a fault signal.

When the temperature of the pump body falls 10 ° C below the set value, it will trigger the TMS low-temperature protection, execute the deceleration shutdown command, automatically shut off the auxiliary heating, and close the TMS cooling water valve. Simultaneously, the "fault status indicator light (red)" will illuminate, and the REMOTE port will output a fault signal.

Note: The cryogenic protection function of the MTP pump will be enabled after a certain delay following startup.

6.2 give an alarm

The "Fault Status Indicator (Orange)" flashing pattern represents different types of alarms. When there are two or more alarms simultaneously, only the high-priority alarm is indicated. Meanwhile, the alarm signal is outputted through the "REMOTE" connector. Both serial communication and monitoring modules can query and set alarm information. For more detailed content, please refer to 3the relevant section.

Table47 Alarm Function

Serial Number	give an alarm	Fault indication LED (orange)	priority
1	Primary damage limit, secondary damage limit (Contact protection bearing alarm function)	Three consecutive flashes	High Priority  Low Priority
2	Operation timeout (operation timeout alarm function)	Continuous two flashes	
3	Overload (overload alarm function)		
4	Unbalance (excessive unbalance alarm function)	Single flash	

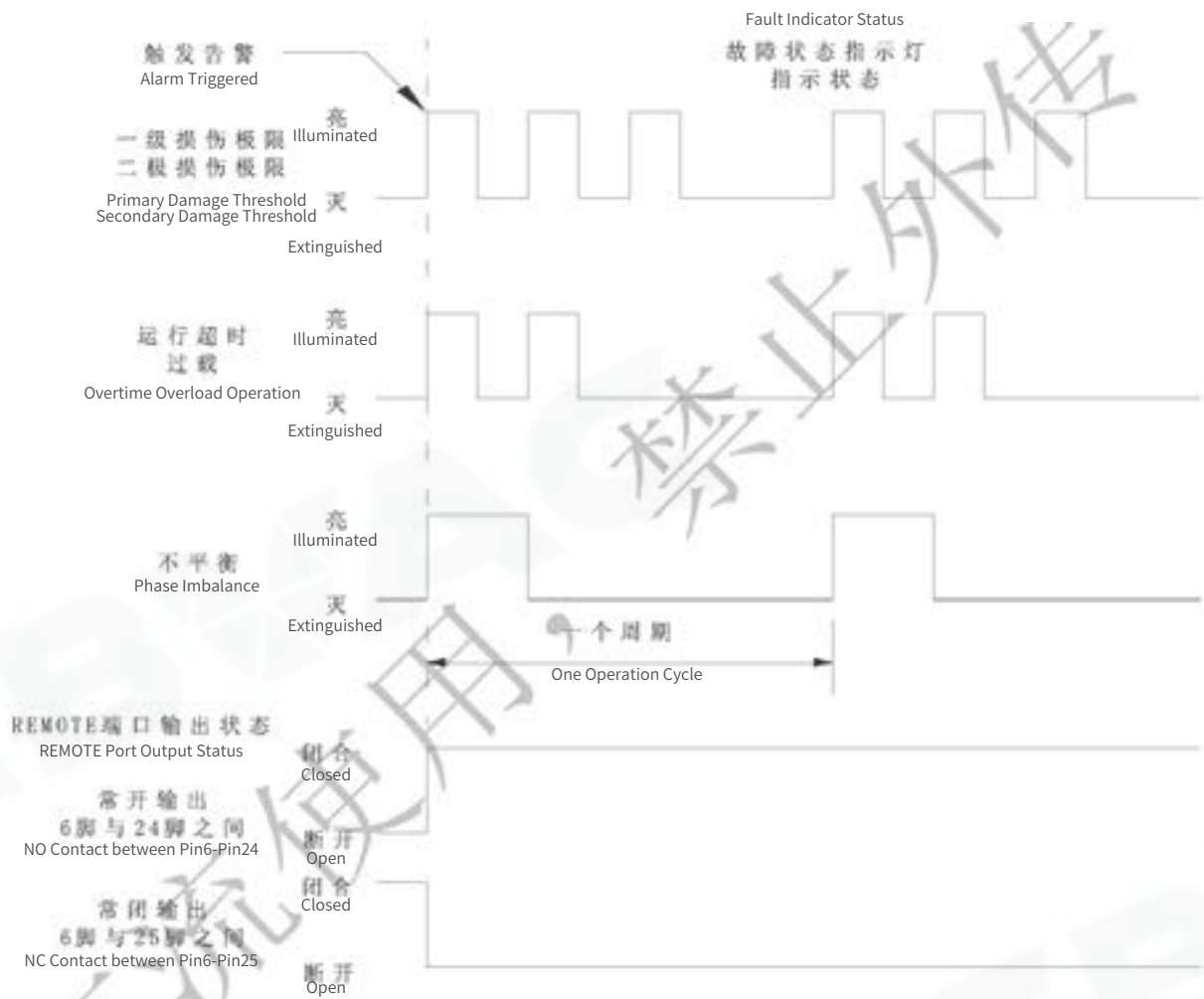


Figure51 Alarm output

Note:

- 1) The alarm cannot be reset via "RESET". For resetting the alarm, please refer to Section "" 6.4 Alarm Configuration
- 2) When the MTP (Magnetic Suspension Molecular Pump) triggers an alarm, it will not automatically shut down, but it is still recommended to conduct a comprehensive inspection of the MTP pump.

6.3 Alarm function

The "Fault Status Indicator (Orange)" flashing pattern represents different types of alarms. When there are two or more alarms simultaneously, only the high-priority alarm is indicated. Meanwhile, the alarm signal is outputted through the "REMOTE" connector. Both serial communication and monitoring modules can query and set alarm information. For more detailed content, please refer to 3th relevant section.

6.3.1 Primary damage limit

Due to external impacts or abnormal power failures of the external power supply, the high-speed rotor of the MTP pump may fall onto the protective bearing and cause wear to the protective bearing during operation. The MTP pump continuously monitors such abnormal conditions and triggers a "level one damage limit" alarm when the cumulative damage reaches a certain level.

The "primary damage limit" function can be disabled through the serial port or monitoring module.

6.3.2 Secondary damage limit

After triggering the "Level 1 Damage Limit" alarm, continue to operate the MTP pump, and when the cumulative abnormal condition of the wear-protected bearing reaches a certain level, it will trigger the "Level 2 Damage Limit (Alarm)" and "Level 2 Damage Limit (Fault)". At this time, the MTP pump will trigger automatic shutdown for protection. Please conduct a comprehensive inspection of the MTP pump at this time.

If the MTP pump needs to continue operating after triggering the "Secondary Damage Limit", the "Secondary Damage Limit" function can be disabled through the serial port or monitoring module.

6.3.3 Operation time exceeded

The time counter can track the operating time of the MTP pump, and will trigger an "operating time timeout" alarm when the operating time reaches the set value. Users can use this function to remind the maintenance schedule for the MTP pump.

The operating time can be read and settings can be changed through the serial port or monitoring module.

6.3.4 overload

"Overload" refers to the condition where the motor current continuously exceeds the set value or the MTP pump speed continuously remains below the set value for a certain period of time. Overload monitoring of motor current and speed is only performed in the "normal operation" mode.

As the operating time increases, residual substances in the MTP pump continue to accumulate, leading to a greater rotor load. The "overload" alarm function can be used to remind maintenance.

The current and speed alarm values can be set through the serial port or monitoring module, and the overload protection function can be disabled.

6.3.5 imbalance

During operation, the MTP pump continuously monitors the rotational stability of the rotor. When the rotor's operational stability exceeds the preset value, an "Unbalance" alarm is triggered.

As the operating time increases, residual substances in the MTP pump accumulate continuously, leading to a greater rotor load and gradually deteriorating rotor stability. When the accumulation reaches a certain level, it can cause the MTP pump to malfunction, at which point the MTP pump requires thorough maintenance.

The setting value for imbalance has been preset at the factory and cannot be altered by the user. However, the "imbalance alarm" function can be disabled through the serial port or monitoring module.

6.4 Alarm setting

The alarm function can be set to be enabled or disabled through serial communication or a monitoring module.

The set values for "operation time overrun" and "overload" can be customized.

After triggering the "Operation Time Overrun" alarm, the set value can be increased to reset the alarm. After triggering the "Overload" alarm, the alarm can be reset by re-energizing the MTP pump.

For default settings, please refer to 表 48 and 表 49. Changes can be made through serial communication.

Alarm function	default setting	User setting permissions	User access modification
Secondary damage limit (fault)	Enable	Enable	Disable
Secondary damage limit (alarm)	Enable	Disable	Disable
Primary damage limit	Enable	Enable	Disable
Operation time exceeded	Disable	Enable	Enable
overload	Disable	Enable	Enable
imbalance	Enable	Enable	Disable

Table:49 Default Settings and Adjustment Range

Alarm function	default setting		Regulation range	describe
Operation time exceeded	0 h		0-100,000 h	The step size is set to 100h. When set to 0, no timing is performed.
overload	motor current	100%	0-100%	The ratio of the current to the rated current. In the "normal operation" mode, an alarm is triggered when the current value exceeds the set value, and the smaller the set value, the easier it is to trigger an alarm.
	rotational speed	0.0%	0-100%	The ratio of the current rotational speed to the rated rotational speed. In "normal operation" mode, an alarm is triggered when the current value is lower than the set value, and the higher the set value, the easier it is to trigger an alarm.

6.5 Fault handling

The MTP pump is equipped with comprehensive protection functions to prevent various abnormalities that may occur during its operation.

In the event of an abnormal situation, the protection function of the MTP pump will immediately activate and display the current fault through the "Fault" indicator light. Simultaneously, the fault signal is also output through the "REMOTE" connector. Users can troubleshoot the abnormal situation based on the fault indication. If the MTP pump still fails to operate normally after troubleshooting, please contact Zhongke Jiuwei after-sales service in a timely manner.

6.5.1 Automatic power restoration

It is recommended to design an automatic power supply system for the MTP pump, so that it can automatically restore power supply.

6.5.2 Other anomalies or alarms

To avoid accidents such as electric shock, water leakage, gas leakage, and malfunctions of the MTP pump that may cause personal injury and equipment damage, please ensure that the power cable of the MTP pump has been removed from the MTP pump body when troubleshooting. Also, confirm that the main power supply has been disconnected, the gas valve has been closed, the water valve has been closed, or other energy sources have been shut off. Please double-check that the MTP pump has stopped rotating. Then, follow the steps below:

(一) Confirm that the "Operating Status Indicator" has been extinguished and the MTP pump has ceased operation. According to the prompt of the "Fault Status Indicator", refer to the suggestions in Table 44 to troubleshoot the fault.

(二) Perform a "reset" operation to reset the fault.

(三) Perform the "start" operation. Observe whether the MTP pump can operate normally.

Note: If the "Reset" operation fails to reset the fault, please re-energize the MTP pump when it is stopped.

6.6 Troubleshooting

6.6.1 Fault status indicator (no display)

Serial Number	phenomenon	Possible cause	Countermeasures
1	0 h motor current rotational speed	0-100,000 h	The step size is set to 100h. When set to 0, no timing is performed.
		0-100%	The ratio of the current to the rated current. In the "normal operation" mode, an alarm is triggered when the current value exceeds the set value, and the smaller the set value, the easier it is to trigger an alarm.
		0-100%	The ratio of the current rotational speed to the rated rotational speed. In "normal operation" mode, an alarm is triggered when the current value is lower than the set value, and the higher the set value, the easier it is to trigger an alarm.
2	After the "Start" command, the "Operation" indicator displays abnormally	The "control port" is set incorrectly	Correctly set up the control port
		The "Do Not Operate" signal pins (pins 1 and 5 of the REMOTE port) are open-circuited	When this function is not in use, please short-circuit pins 1 and 5 or keep pins 1 and 2 of the REMOTE port open-circuited
3	The "Do Not Operate" signal is not functioning	"Operation prohibited" is not enabled	The 1st and 2nd pins of the REMOTE port are short-circuited

Serial Number	phenomenon	Possible cause	Countermeasures
4	Insufficient pressure	Front-stage pump failure	Check the capacity and startup status of the backing pump (replace it with a backing pump of larger capacity)
		Leakage in pipeline system	Inspect the pipeline
		Residual molecules	1. The main component is H ₂ or H ₂ O. Please perform heating treatment 2. For other gases, please clean the interior of the vacuum equipment 3. The fault remains unresolved. Please contact after-sales service
5	abnormal noise	External vibration or impact exists	Eliminate external vibration

6.6.2 Fault status indicator light (green)

When the "Fault" indicator light turns green after power-on, it indicates that there is an abnormality or alarm during the system self-check process, suggesting that the MTP pump may be faulty. Please contact after-sales service.

6.6.3 Fault status indicator light (red)

The "Fault Status Indicator (Red)" flashes at different frequencies to represent different fault conditions. When multiple faults occur simultaneously, the fault with the highest priority will be displayed. Additionally, the fault signal will also be output from the "REMOTE" connector. If the fault indicator is lit in red, please refer to 表 51 the corresponding measures.



Serial Number	fault	Fault LED indication	priority
1	Abnormal power loss of external power supply speeding Or other malfunctions	Steady red light	High Priority
2	motor overheating Internal overheating of the controller	Three consecutive flashes	
3	Motor drive overload	Two consecutive flashes	
4	disturbance	Single flash	

Figure52 Fault Output
Table51 Priority of Fault Signals
Table52 Fault List

Fault indication	fault information	Protection method	Conditions for fault occurrence	Causes of malfunction	measure
One flash	AY disturbance AX disturbance BY disturbance BX disturbance Z-perturbation	Slow down and stop	imbalance	External factors: 1. External vibration or impact 2. Air enters the MTP pump 3. Foreign matter falls into the MTP pump 4. Sudden pressure change	1. Eliminate vibration sources 2. Inspect the vacuum tube 3. Avoid foreign objects falling 4. Adaptation of backing pump
				Magnetic bearing anomaly: 1. Control circuit fault 2. Wiring harness open circuit	Contact after-sales service
Continuous flashing twice	Motor drive overload	Slow down and stop	Failed to reach the set rotational speed within 30 minutes	1. High pressure exists at the inlet and outlet 2. Leakage in pipeline system 3. Front-stage pump failure	1. Operating at near the maximum working pressure 2. Check the vacuum pipeline system for leaks 3. Check the capacity and startup status of the backing pump
Three consecutive flashes	motor overheating	Slow down and stop	Overheating inside the MTP pump	1. Excessively high heating temperature 2. Insufficient cooling 3. Leakage in vacuum pipeline system 4. Repeated start/stop operation 5. fan failure	1. The temperature setting for auxiliary heating should not exceed 120°C 2. When the MTP (Magnetic Suspension Molecular Pump) is operating, continuous cooling is maintained 3. Check the pipeline system for any leaks 4. Overheating caused by multiple repeated start/stop operations 5. Contact after-sales service for replacement of the cold air fan
Three consecutive flashes	Internal overheating of the controller	Slow down and stop	Internal overheating of the controller	1. The ambient temperature is too high 2. The cooling of the controller is insufficient 3. Cold air fan malfunction	1. The ambient temperature must not exceed 40°C 2. Set the cooling water flow rate to 3L/min, and maintain the cooling water temperature within the range of 15°C to 35°C 3. Contact after-sales service for replacement of the cold air fan
Red constant light	Abnormal acceleration	Free stop*1	Excessively high rotational speed	The gas flow passes through the interior of the pump	1. Check the vacuum pipeline system for any leaks 2. Check the exhaust sequence 3. Turn off the power and wait for the MTP pump to stop running 4. Power on again
	Communication Failure	Slow down and stop	Controller communication failure	Controller fault	Contact after-sales service

*1: When the MTP (Magnetic Suspension Molecular Pump) system is in free shutdown, the rotor continues to rotate due to inertia, potentially lasting for several hours. To quickly stop the MTP pump, close the vacuum valve on the outlet port flange and introduce gas from the exhaust pipe into the MTP pump.

Fault List (Continued)

Fault indication	fault information	Protection method	Conditions for fault occurrence	The cause of the malfunction	measure
Red light is constantly on	Abnormal braking	1. Free running 2. Slow down and shut down	If the deceleration time exceeds 30 minutes, it will automatically enter the braking state	Controller failure	Contact after-sales service
	Acceleration fault	Slow down and stop	Rotating speed below 2000rpm	1. External influence 2. Controller fault	1. Restart after resetting 2. Contact after-sales service
	Motor drive failure	Slow down and stop	Motor controller communication fault	1. External interference 2. Controller malfunction	1. Restart after resetting 2. Contact after-sales service
	Motor drive communication failure	Slow down and stop	Motor controller communication fault	Controller failure	Contact after-sales service
	Motor drive overcurrent	Free stop	Motor overcurrent	1. Short circuit between motor windings or short circuit of windings to ground 2. Controller failure	Contact after-sales service
	Motor drive overvoltage	Free stop	Motor overvoltage	Controller fault	Contact after-sales service
	fan failure	Slowdown and shutdown	The cooling fan has stopped	1. The cooling fan is damaged 2. Controller fault	Contact after-sales service
	Current runaway	The magnetic bearing ceases to operate, causing the rotor to fall onto the protective bearing	The magnetic bearing overcurrent lasts for approximately 30 seconds	1. MTP pump malfunction 2. Controller fault	Contact after-sales service
	Temperature detection open circuit	Slow down and stop	Abnormal motor temperature detection	Motor temperature sensor open circuit	Contact after-sales service
	speeding	Slow down and stop	The rotational speed exceeds the preset value	Controller failure	Contact after-sales service
	Abnormal power loss of external power supply	Slow down and stop	Abnormal power loss	1. Abnormal power failure 2. Abnormal power supply cable 3. Abnormal supply voltage	1. Is there an abnormal power loss 2. Replace the power cord 3. Ensure that the power supply voltage meets the requirements.
			Controller overheating	1. Insufficient cooling capacity 2. Controller fault	1. Check the volume and temperature of the cooling water. Turn off the power and re-energize it after three minutes 2. Contact after-sales service
	Power Failure	Slow down and stop	Power supply failure of the controller	Controller failure	Contact after-sales service
	RAM error	Slow down and stop	RAM check failed	Controller failure	Contact after-sales service
	velocity anomaly	Slow down and stop	Abnormal speed detection	Controller fault	Contact after-sales service
	Secondary damage limit	Slow down and stop	Accumulated damage exceeds the set value	Alternately display "disturbance" and "power supply" alarms	Contact after-sales service

Fault List (Continued)

Fault indication	fault information	Protection method	Conditions for fault occurrence	Causes of malfunction	measure
Red light is constantly on	Communication failure	Slow down and stop	During acceleration or normal operation, communication failure occurs	1. The tool software settings are incorrect 2. Abnormal communication cable 3. Controller malfunction	1. Communicate at a communication cycle lower than the set value 2. Check the communication cables 3. Contact after-sales service
	TMS overheating	Slow down and shut down	The TMS functional test temperature exceeds the set temperature by 10°C	1. TMS functional cooling failure 2. TMS functional failure	1. Check the cooling circuit, cooling water temperature, and water capacity 2. Contact after-sales service
	TMS temperature is too low	Slow down and stop	The temperature detected by the TMS function is 10° C lower than the set temperature (the MTP pump will not trigger an excessively low temperature fault within a short period of time after startup)	1. TMS auxiliary heating failure 2. TMS functional failure	Contact after-sales service
	TMS signal fault	Slow down and stop	When using "TMS", the sensor of TMS is not connected	1. TMS sensor not connected 2. TMS cable is not connected 3. TMS cable fault 4. The TMS function setting is incorrect	1. Contact after-sales service 2. Ensure that the wiring harness is connected correctly 3. Contact after-sales service 4. When the TMS function is not in use, configure it as "Disabled"

7 Management and inspection

Installation, operation, and maintenance must be performed by personnel who have carefully read this manual and possess specific skills in installing, operating, and maintaining MTP pumps. When installing and maintaining an MTP pump, please confirm that the power cable has been disconnected from the MTP pump, and double-check that the MTP pump has stopped operating.

7.1 Maintenance and inspection

(一) When performing maintenance and overhaul on the MTP pump, please confirm whether there are any harmful substances remaining inside the MTP pump and ensure proper personal safety precautions to prevent personal injury incidents.

(二) To avoid accidents such as electric shock, water leakage, gas leakage, and malfunctions of the MTP pump that may cause personal injury and equipment damage, when performing maintenance or inspection, please ensure that the power cable of the MTP pump has been removed from the MTP pump body, and confirm that the main power supply has been disconnected, the gas valve has been closed, the water valve has been closed, or other energy sources have been shut off. Reconfirm that the MTP has stopped rotating.

(三) Due to the different laws and regulations in each region, the solvents and contaminants used for cleaning may pose a pollution risk. Please dispose of cleaning waste properly.

(四) To avoid malfunctions in the MTP pump, do not touch the internal components during maintenance and inspection, and it is strictly prohibited to open any panels.

7.2 maintenance

7.2.1 maintenance

Conducting maintenance according to the specified maintenance cycle can extend the service life of the MTP pump and maintain its safety. (The maintenance costs are borne by the user.).

The following outlines the recommended maintenance intervals for various process applications:

Table:53 Recommended Maintenance Intervals

workmanship		cycle	notes
Etching *1	Metal etching process (deposition)	1 year	If there is deposition, the maintenance cycle needs to be shortened (including non-etching processes)
	Other etching processes	2 years	
Other semiconductor processes		2 years	
Clean application		5 years	No gas used
other purposes		2 years	Depending on the actual situation, please contact Zhongke Jiuwei

*1: "Etching" includes semiconductor etching and liquid crystal etching.

Note: When an "First-Level Damage Limit" alarm or "Second-Level Damage Limit" is detected, the protective bearing should be replaced promptly, even if the maintenance schedule has not been reached.

The "Damage Limit" alarm will be indicated through the "Fault" indicator light (flashing orange three times in succession) or the monitoring module.

7.2.2 Replace protective components

The maintenance of MTP pumps involves replacing protective components, such as upper and lower protective bearings and standard parts like O-rings.

7.2.3 Recommended maintenance intervals for main components

In practical applications, the internal components of MTP pumps are subject to long-term wear and tear due to gas loads, temperature, corrosion, and other factors. Excessive wear of the internal components of MTP pumps can lead to pump malfunction. Therefore, it is recommended to replace the wear-prone components during maintenance of MTP pumps. Please refer to the following table:

Table54: Recommended maintenance intervals

component		Suggested maintenance interval (years)*1	
		corrosive gas	Inert gas or pumping
Rotating vane		3	5
rotation axis		3	5
Motor, sensor, magnetic material, connector		5	7
fan		5	
PCBA		7	
accessory	TMS valve	3	
	TMS-assisted heating	3	
	Connects Cables	5	

*1: The replacement interval may vary depending on the actual operating conditions.

- (一) When damage or excessive wear is found on the components of the MTP pump, the components should be replaced promptly.
- (二) When it is necessary to repair the MTP pump, please contact after-sales service.

7.3 clean

The cleaning method for MTP pumps is as follows:

- (一) Clean the exterior of the MTP pump using a solvent as required. It is recommended to use an alcohol solvent.
- (二) When dust accumulates in the connector, please purge it with pure and dry gas.
- (三) Wipe the exterior with a soft, dry cloth.
- (四) When dust accumulates at the ventilation port, please wipe it off with a cleaning agent or use a vacuum cleaner to clean it, and avoid letting dust enter the interior.
- (五) When the label of the MTP pump is damaged, please contact after-sales service.
- (六) The cleaning (maintenance) of the MTP pump is carried out in the maintenance workshop. Please contact after-sales service.

7.4 transport

When preparing to ship the MTP pump back to Zhongke Jiuwei, please ensure proper packaging to prevent any damage during transportation. Zhongke Jiuwei will not be responsible for any damage to the MTP pump caused by inadequate packaging.

Before conducting maintenance on the MTP pump or using it for other purposes, please contact the service personnel of Zhongke Jiuwei. To prevent the corrosive substances remaining in the MTP pump from damaging the pump body and electrical components:

- (一) Before transportation, it is essential to ensure that the MTP pump is vacuum-sealed;
- (二) In the "Return Statement", it is imperative to clearly specify the type of gas used and the precautions for handling;
- (三) Ensure proper packaging to prevent contamination and leakage.
- (四) It is recommended to use the original packaging or more advanced packaging materials and methods for packaging.

8 Storage and disposal

8.1 storage

When the MTP pump is not in use for an extended period (over several months), please ensure the following measures are taken:

- (一) The MTP pump is placed in a vertical position.
- (二) Seal the inlet of the MTP pump and use a backing pump to evacuate it.
- (三) Inject dry nitrogen through the outlet or purge port.
- (四) Seal the outlet and purge port.
- (五) For water-cooled MTP pumps, please purge with compressed air from the side of the cooling water inlet to ensure that there are no residual substances such as cooling water inside the water cooling tube of the MTP pump.
- (六) Do not store MTP pumps in the following areas:
 - 1. High humidity exists (please isolate and seal it from the outside and use a desiccant, which should be replaced regularly)
 - 2. There are extreme temperatures (high temperatures not exceeding +55°C and low temperatures below -25°C)
 - 3. Presence of corrosive gas
 - 4. Presence of dust
 - 5. Insufficient ventilation
 - 6. There is strong magnetic and electric field radiation
 - 7. direct sunlight
 - 8. Presence of mist
 - 9. Vibration exists

8.2 Scrapping

Please dispose of the MTP pump in accordance with local laws and regulations.

Note: Zhongke Jiuwei will not be responsible for any issues arising during and after the processing period.