

AQMS-200

Dynamic Dilution Calibrator

User Manual

Preface

User Information

We are grateful for your choice of dynamic dilution calibrator, AQMS-200. Prior to using the AQMS-200, please read the user manual carefully. This manual contains all important information and data explaining how to operate the instrument, and the user must strictly comply with them to ensure a normal operation of AQMS-200.

Overview

This manual elaborates on the operation and maintenance of AQMS-200; meanwhile, it describes the working principle, structural composition and performance feature of AQMS-100. This manual is a guide book for trained technicians or any users who have knowledge of instrument operation (for example, automation technology).

Main contents of this manual are shown as follows.

Chapters	Content
1. AQMS-200 Overview	It mainly describes the working principle, technical indices and precautions for use of AQMS-200.
2. AQMS-200 Construction	It mainly describes the structure and appearance of AQMS-100.
3. AQMS-200 Installation	It mainly describes the process and precautions for installation of AQMS-200.
4. Daily Maintenance and Storage	It mainly describes the work for maintenance of AQMS-200.
5. FAQ and troubleshooting	It mainly describes frequently asked questions (FAQ) and diagnostic methods in operation of AQMS-200.
6. Alarm Information and Processing	It mainly describes the alarm information of AQMS-200 and processing methods.
7. Software operation	It mainly describes the software operation of AQMS-200.

It is impossible for this manual to provide detailed description for each product model due to many practical reasons; please contact with Customer Service Department (see the back cover or technical support in Preface of this manual for contact information) for help if you want to acquire further relevant information or solve questions that are not involved in this manual.

Executive Standard

The instrument is compliant with the Enterprise Standard for Dynamic dilution calibrator Q/ 37-2012.

Warnings, Cautions and Notes

Safety standard is always put as top priority in every procedure all through the development, manufacture, test and archiving. In order to ensure personal safety and avoid property loss in using and maintaining the product, this manual incorporates relevant notes, cautions and warnings, which are shown by specific icons together with corresponding explanatory text. The meaning of WARNINGS, CAUTIONS AND NOTES signs is clarified as below.

Sign	Clarification
	NOTES: Alert the user to pertinent facts and conditions.
	CAUTIONS: Hazards which will result in equipment or property damage.
	WARNINGS: Hazards which will result in personal injury or death.

Warranty and Maintenance

Specific warranty and maintenance terms please refer to the clauses on the contract.

Within the warranty period we will provide free maintenance services including product maintenance, maintenance and replacement of spare parts, technical supports and routine field services, etc.

Some malfunctions, if when they occur within the warranty period, would be charged. These malfunctions include but are not limited to:

- 1.) Misoperation (leading to water immersion, corrosion, fire, connecting in series with strong current, etc.);
- 2.) Damage caused by force majeure (earthquake, lightning strike, flood, etc.);
- 3.) Unauthorized internal product modification;
- 4.) Operation against the user manual or training instructions, leading to product damage.

Products developed and manufactures by shall be disposed in strict accordance with national stipulations with respect to disposal of waste products.

Legal Statement:

bears no legal liability for users in regard to the contents of this manual. Please refer to the legal clauses in corresponding contract.

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1 AQMS-200 Overview

1.1 Introduction

Dynamic dilution calibrator AQMS-200 is a high-precision instrument produced by specially for environmental protection industry to calibrate gas analyzers, and it can be used for calibrating ambient air quality detecting instruments and indoor air quality detecting instruments, as well as for quality control of laboratory analysis and gas analysis instrument production. The instrument has such advantages as high responsivity, high repeatability, high precision and easy to operate.

Based on the proportion of standard gases controlled by a mass flowmeter, AQMS-200 can produce standard gases with the grade of nmol/mol~ μ mol/mol (ppb~ppm); the instrument can use 4 circuits of standard gases, with ozonator and ozone spectrophotometer optional according to users' demand. An ozonator is used to generate standard ozone gas, with gas-phase titration used internally to react with NO for produce NO₂; An ozone spectrophotometer is used to measure the ozone concentration to ensure the precision of ozone produced by the ozonator. AQMS-200, together with the ozonator and ozone spectrophotometer can realize the production and testing with special requirement for ozone concentration.



Figure 1-1 Appearance of Dynamic dilution calibrator AQMS-200

1.2 Principle and Technology of Measurement

1.2.1 Working Principle of Basic Units

The basic units of AQMS-200 are two mass flow controllers, one serves as the dilution gas flow controller with measuring range of (0~10) SLPM (with 5 SLPM or 20 SLPM optional), and the other

serves as the standard gas flow controller with measuring range of (0~100) sccm (with 50 sccm or 200 sccm optional). By setting the two flow mass flow controllers, the standard gas with required concentration can be obtained by diluting proportionally.

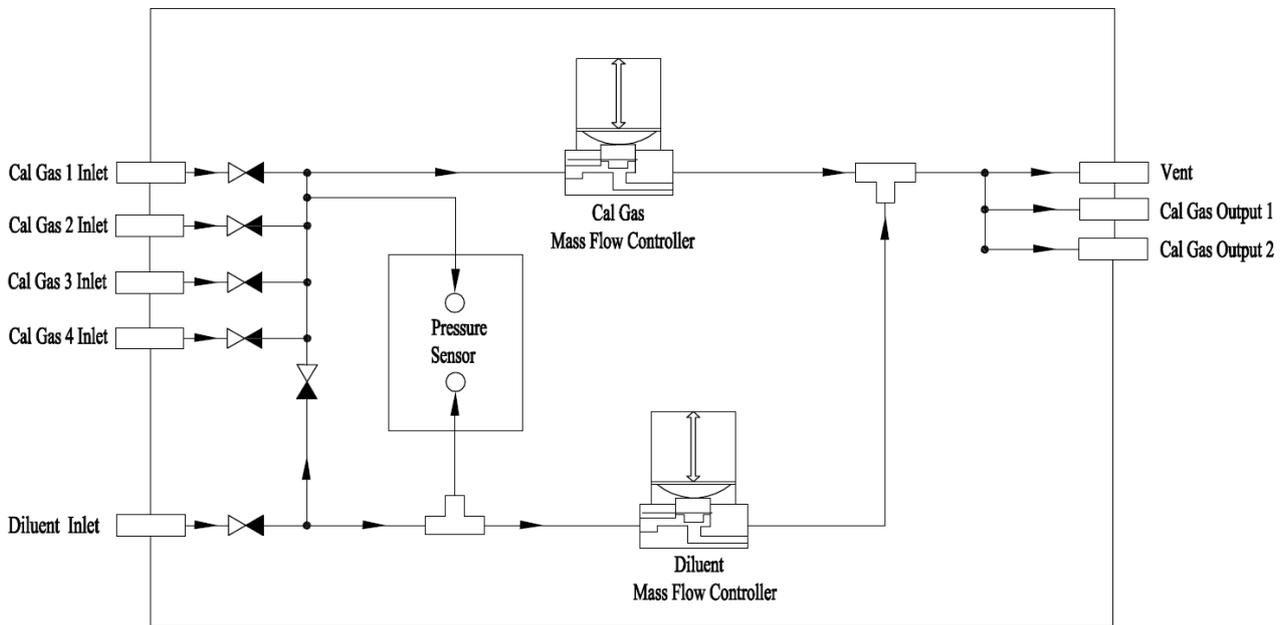


Figure 1-2 Schematic Diagram of AQMS-200 Gas Circuit (Basic Unit)

1.2.2 Working Principle of Ozonator

Due to its strong oxidation, generally, ozone (O₃) can't be contained and stored in steel cylinders, and thus the ozonator is required. With UV photochemical method, the ozonator can produce high-precision and low-concentration O₃, which is very suitable for O₃ calibration.

The UV source installed in the ozonator can emit UV light with 185nm wavelength, zero-level air is guided into the ozonator, and O₂ after adsorbing 185 nm UV light will turn into O₃.



1.2.3 Measuring Principle of Ozone Spectrophotometer

The ozone spectrophotometer works on the basic principle of Beer-Lambert relation; namely, under given temperature and pressure, within certain optical length, gas with certain concentration can adsorb the light with certain wavelength. Under standard temperature and pressure (STP), the relation can be expressed as follows:

$$I = I_0 e^{-\alpha LC} \quad \text{at STP}$$

Where,

I_0 I_0 is initial light intensity, in W/m²;

I I is the light intensity after being adsorbed by gas, in W/m²;

L L is the optical length that can be adsorbed by gas;

C is the concentration of adsorption gas (O₃ in this case);

α is the absorption coefficient of O₃ at certain wavelength;

From the equation above, O₃ concentration can be inferred as:

$$C = \ln \frac{I_0}{I} \times \frac{1}{\alpha L} \quad \text{at STP}$$

However, ambient temperature and pressure can affect the gas density, thus change the UV light that is adsorbed by O₃. Considering the effect of temperature and pressure, the formula for computing concentration is refined as:

$$C = \ln \frac{I_0}{I} \times \frac{1}{\alpha L} \times \frac{T}{273} \times \frac{14.69598}{P}$$

Where,

T is the temperature of sample gas, in K;

P is the pressure of sample gas, in PSI.

When gas temperature, gas pressure, and the UV intensity with/without O₃ existed are measured, given the optical length of gas adsorption chamber and the O₃ adsorption coefficient, the O₃ concentration can be calculated from the equation above.

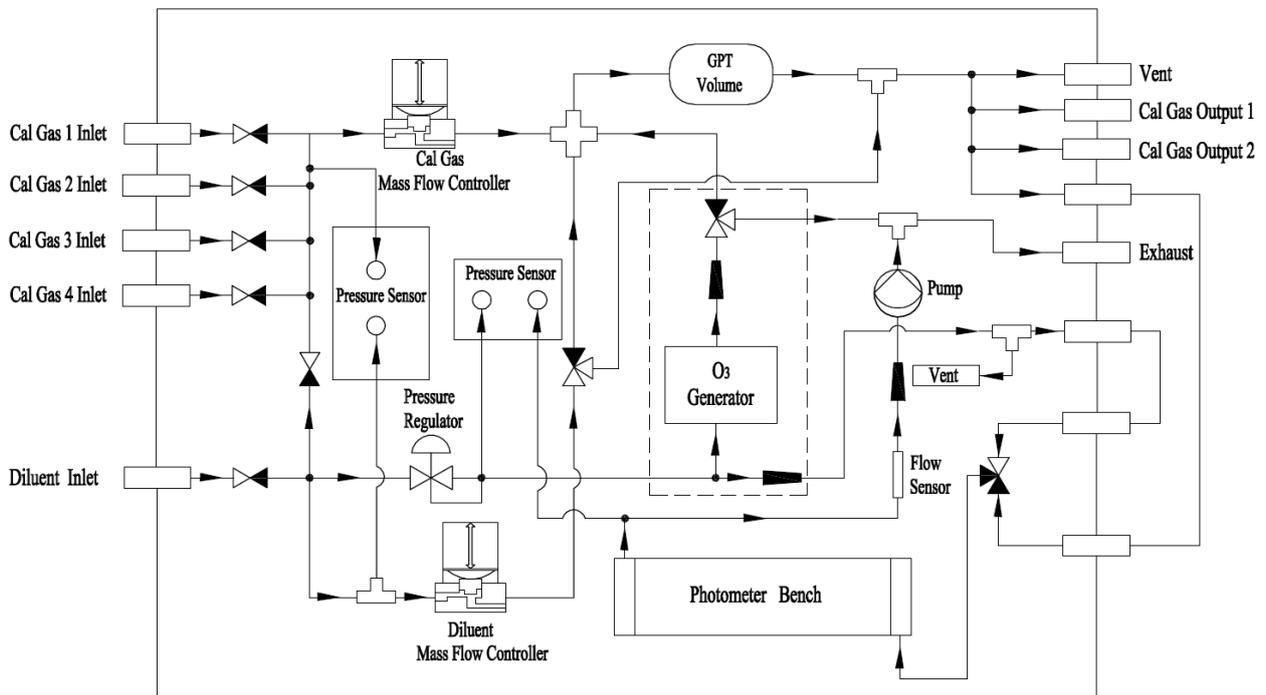


Figure 1-3 Schematic Diagram of AQMS-200 Gas Circuit (with Ozonator and Photometer)

1.3 Technical Index

Table1-1 Specifications and Technical Parameters

Item	Parameter	Index
Basic unit (Gas diluting and proportioning part)	Flow range of dilution gas	(0~5) SLPM,(0~10) SLPM or (0~20) SLPM, optional
	Flow range of standard gas	(0~50) sccm, (0~100) sccm or (0~200) sccm, optional
	Accuracy of flow control	±1% F.S.
	Flow linearity	± (0.5~1)% F.S.
	Repeatability of flow control	± 0.2% F.S.
	Standard gas inlet	4
	Dilution gas inlet	1
	Response time	60 s (98%)
Ozonator	Output	(0.1~6) μmol/mol (ppm)
	Stability	±1% F.S./7 days (with photometer); ±3%/7 days (without photometer)
	Linearity	< 1% (with photometer); < 3% (without photometer)
Ozone spectrophotometer	Span	0~100 ppb to 0~10 ppm (Selectable)
	Accuracy	1.0 nmol/mol (ppb)
	Linearity	1% F.S.
	Rise/fall time	<20 s
	Response time	180 s (98%)
	Zero drift	< 1.0 nmol/mol (ppb)/7days
	Span drift	< 2%/7 days
	Standard gas flow	800 sccm
Overall unit	Power supply	(220~240) V AC; (45~55) Hz
	Overall size (H×W×D)	(178×432×604) mm
	Weight	<15 kg (basic unit) < 20 kg (including ozonator and ozone spectrophotometer)
	Working temperature	(5~40)°C
	Working humidity	(0~95)% RH
	Protocol	Support RS232, RS485 and Ethernet communication (optional)

1.4 Precautions for Use

- Do not open the instrument arbitrarily.
- Keep water away from the instrument.
- Keep away naked fire and heat source from the instrument.
- The instrument shall be handled gently to avoid violent impact; otherwise it will be damaged.
- When using, the instrument shall not be placed where there are high-power motors, heaters, welding equipment, radio transmitting equipment, pulse magnetic resonance instruments or high-power lasers, because these devices may disturb the use of AQMS-200.
- AQMS-200 shall be connected with AC power supply that can provide at least 10A current and well grounded.
- When the instrument is running, the cover plate of photometer shall not be opened to avoid staring at the mercury lamp directly, otherwise eyes may be damaged.
- When carrying out leakage self-check, the 15 psi pressure sensor and flow sensor must be tripped off, otherwise the sensors may be damaged.

2 AQMS-100 Construction

AQMS-200 is designed through the methods of integration and modularization, with modules mainly integrated inside the instrument cabinet. Its appearance is shown in Figure 2-1 and its size is shown in Figure 2-2.



Figure 2-1 Appearance of AQMS-200

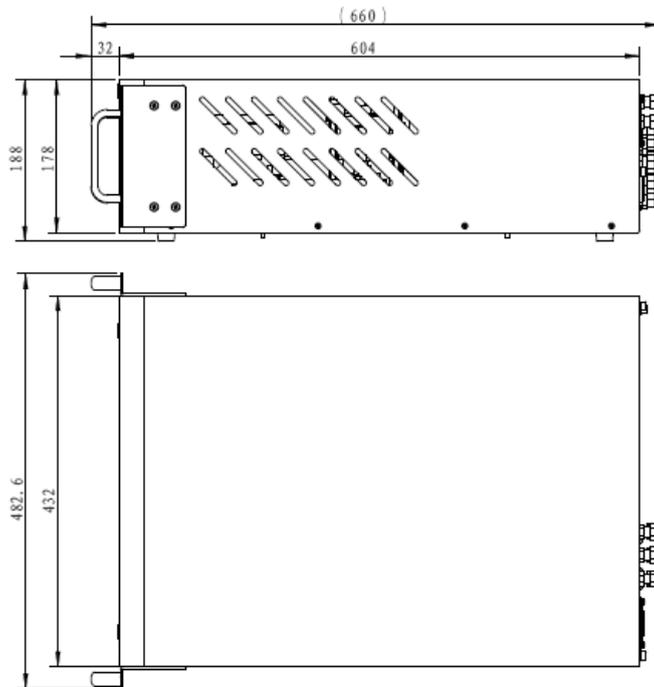


Figure 2-2 Size of AQMS-200

2.1 AQMS-200 Front View

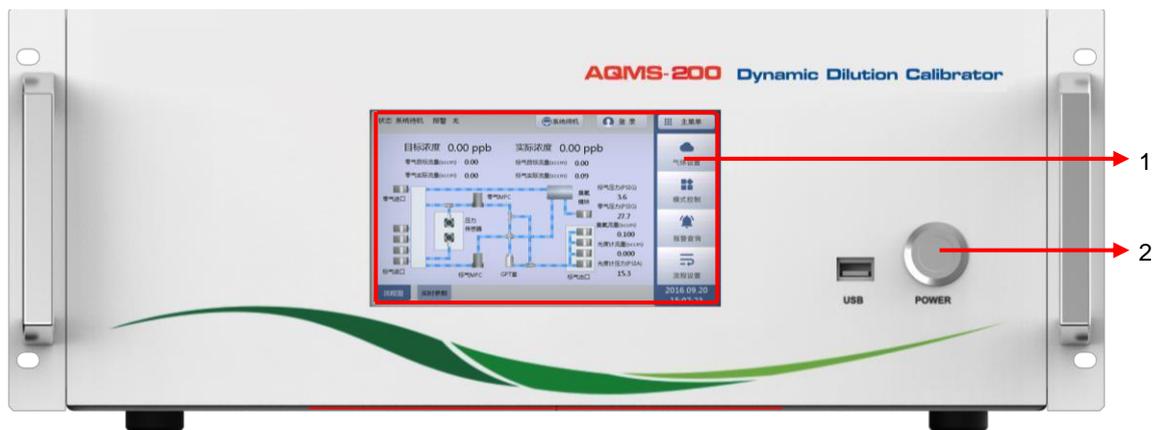


Figure 2-3 AQMS-200 Front View

Table2-1 Name and Function of All Parts in Front View

No.	Name	Function
1	Operation panel	The operation panel consists of a LCD display and keys. Users are allowed to carry out all operations through the user-friendly interface together with the keys.
2	Power switch	—

NOTE:

For Detailed description about LCD operations and key functions see 7 Software Operation in the User Manual.

2.2 AQMS-200 Rear View

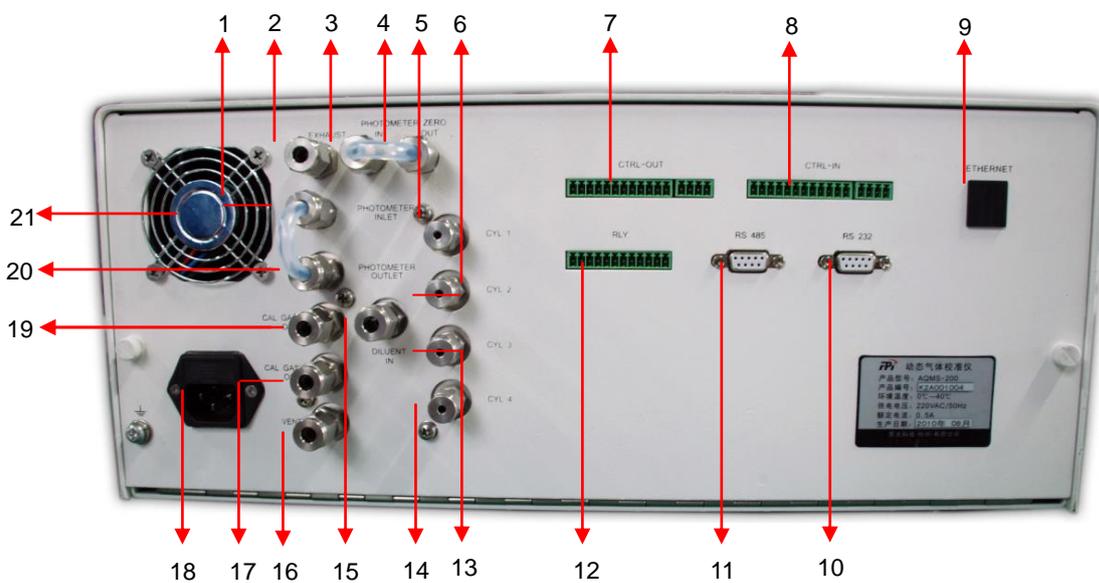


Figure 2-4 AQMS-200 Rear View

Table2-2 Name and Function of All Parts in Rear View

No.	Name	Spec./inch
1	Photometer inlet	φ1/4
2	Gas outlet	φ1/4
3	Zero gas inlet of photometer	φ1/4
4	Zero gas outlet of photometer	φ1/4
5	Standard gas inlet 1	φ1/8
6	Standard gas inlet 2	φ1/8
7	Digital value control output	–
8	Digital value control input	–
9	Ethernet interface	–
10	RS232	–
11	RS485	–
12	Relay output	–
13	Standard gas inlet 3	φ1/8
14	Standard gas inlet 4	φ1/8
15	Dilution gas inlet	φ1/4
16	Vent hole	φ1/4
17	Standard gas outlet 2	φ1/4
18	Adapter interface	–
19	Standard gas outlet 1	φ1/4
20	Photometer outlet	φ1/4
21	Fan	–

2.3 AQMS-200 Internal View

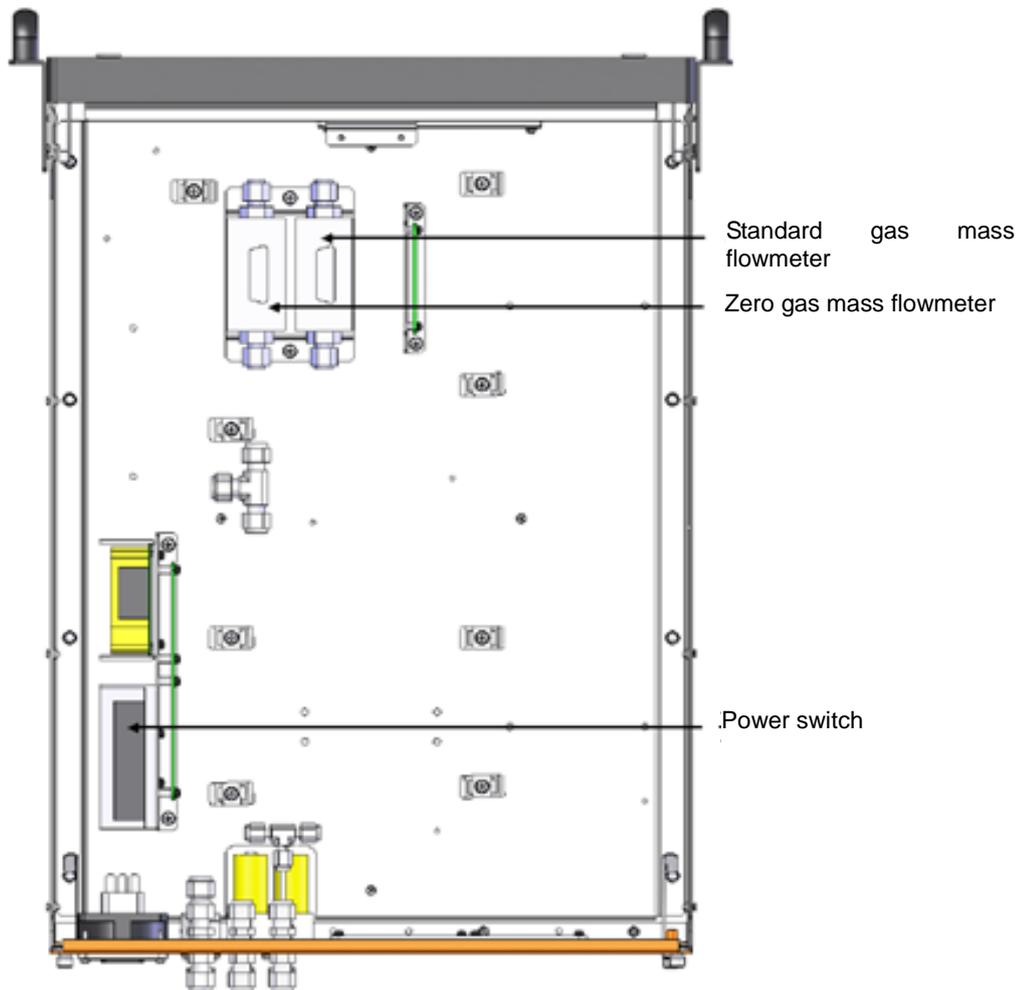


Figure 2-5 AQMS-200 Internal Structure (Basic Unit)

Table2-3 Name and Specification of Internal Structure (Basic Unit)

Name	Spec.
Zero gas mass flowmeter	(0~10) SLPM (5 SLPM or 20 SLPM, optional)
Standard gas mass flowmeter	(0~100) sccm (50 sccm or 200 sccm, optional)
Power switch	—

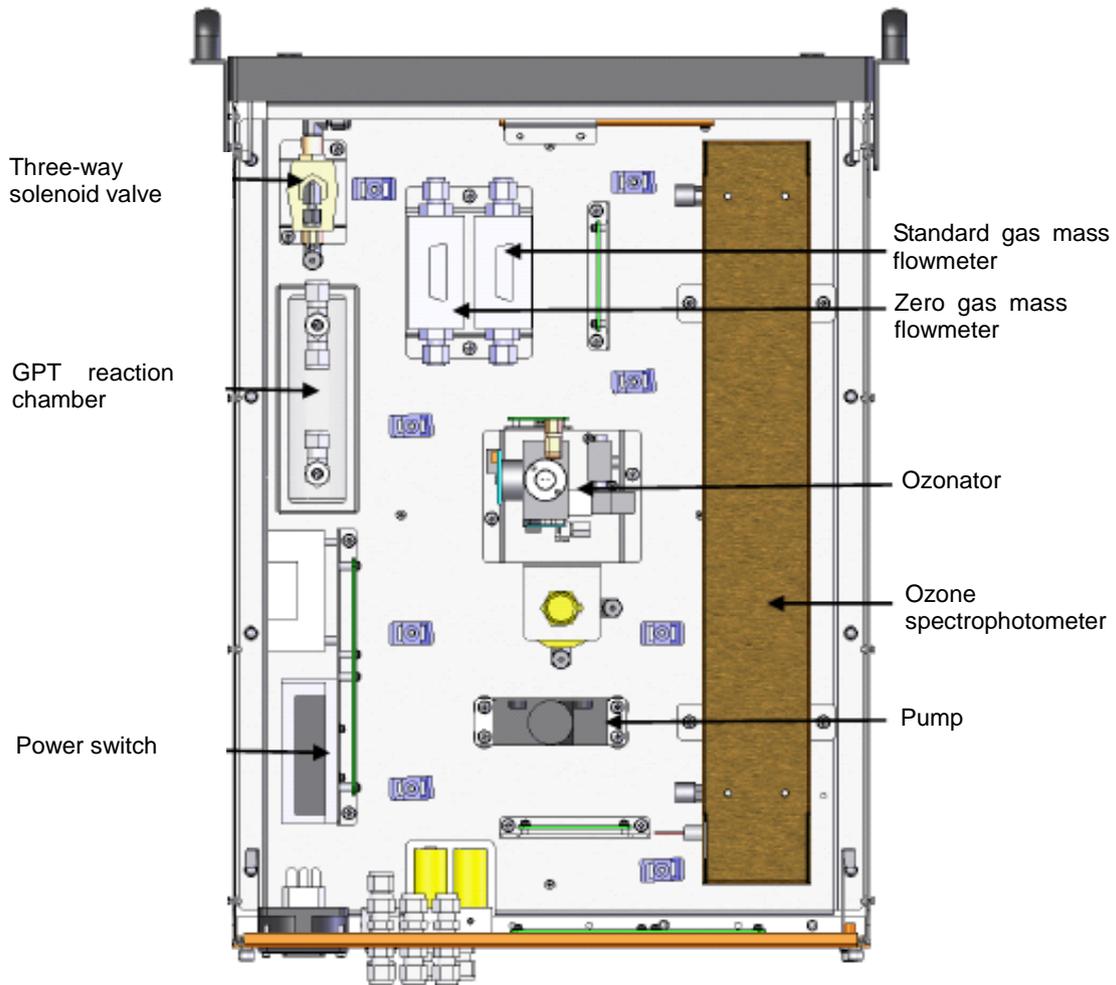


Figure 2-6 AQMS-200 Internal Structure (with Ozonator and Photometer)

Table2-4 Name and Specification of Internal Structure (with Ozonator and Photometer)

Name	Spec.
Zero gas mass flowmeter	(0~10) SLPM (5 SLPM or 20 SLPM, optional)
Standard gas mass flowmeter	(0~100) sccm (50 sccm or 200 sccm, optional)
Ozonator	—
Ozone spectrophotometer	—
Pump	—
Power switch	—
GPT reaction chamber	—
Three-way solenoid valve	—

3 AQMS-200 Installation

3.1 Basic Requirements for Installation Site

3.1.1 Installation Site

AQMS-200 shall be installed at a site with no magnetic field interference, no corrosive gas, and no intensive or sustained vibration; there should be no obstructions around the instrument; the room shall have some atmospheric conditions. The operating floor for the instrument shall be firm, stable and reliable.

3.1.2 Installation Conditions

The basic requirements in installing and using AQMS-200 for environment are as follows:

- Environment temperature: (5~40) °C
- Relative humidity: (0~95)% RH

CAUTION:

The measurement accuracy and service life of the instrument may be influenced if the basic conditions can't be met by actual conditions of the user.

According to the requirement for measurement accuracy, it is recommended that the laboratory temperature shall keep steady to avoid sharp and frequent changes, so as to ensure accurate results.

3.2 Basic Requirements for Operators

AQMS-200 is an optical instrument of high precision. In order to ensure proper use and reliable operation and to reach particular measurement standards, the operator shall have a certain degree of professional knowledge or meet the following conditions through training:

- 1.) Possessing certain knowledge about instrument operation and some operating skills; and
- 2.) Having preliminary understanding to the basic principle and maintenance knowledge of optical instruments or having used optical instruments before.

3.3 Utilities

Before installing the software system, following conditions shall be confirmed (following contents are for information only, and AQMS-200 Engineering Construction Scheme shall be followed, specifically):

Table3-1 Preparation before System Installation

No.	Item Prepared	Technical index	Material Model	Start Point	End Point	Remark
1	Power cable	(220±10%) V AC; (50±1%) Hz; 0.5 kW	RVV 3×1.5 mm ² Outer diameter (8~10) mm	Power Module of User	AQMS-200	All cables are laid in pipes, with allowance left.
2	Signal cable	Shield cable	RVVP 8×0.75 Outer diameter (8~10) mm	Industrial control computer	AQMS-200	All cables are laid in pipes, with allowance left.
3	Grounding	Grounding resistance ≤ 4 Ω	Grounding cable larger than 1×4 mm ²	–	–	One separate grounding conductor shall be provided
4	Zero gas and standard gas	50 μmol/mol (ppm) SO ₂ , NO 5000 μmol/mol (ppm) CO	–	User meter	AQMS-200	–

3.4 Instrument Installation

3.4.1 Unpacking and Checking

When the instrument is received, the user shall firstly check the goods against the packing list of instrument. In checking, special attention shall be paid to whether the goods name, model and quantity are consistent with the packing list or not; if so, the packages of each part shall be unpacked for further checking.

CAUTION:

External conditions of instrument packing shall be checked before unpacking for checking internal goods. If damage is found, the damaged goods must be well kept and then the manufacturer shall be contacted for a solution.

3.4.2 Connection of Gas Circuit

AQMS-200 is applied to ambient air quality automatic monitoring system. The system flow path is shown in Figure 1-3 Schematic Diagram of AQMS-200 Gas Circuit, and its typical connection of gas circuit is

shown as follows:

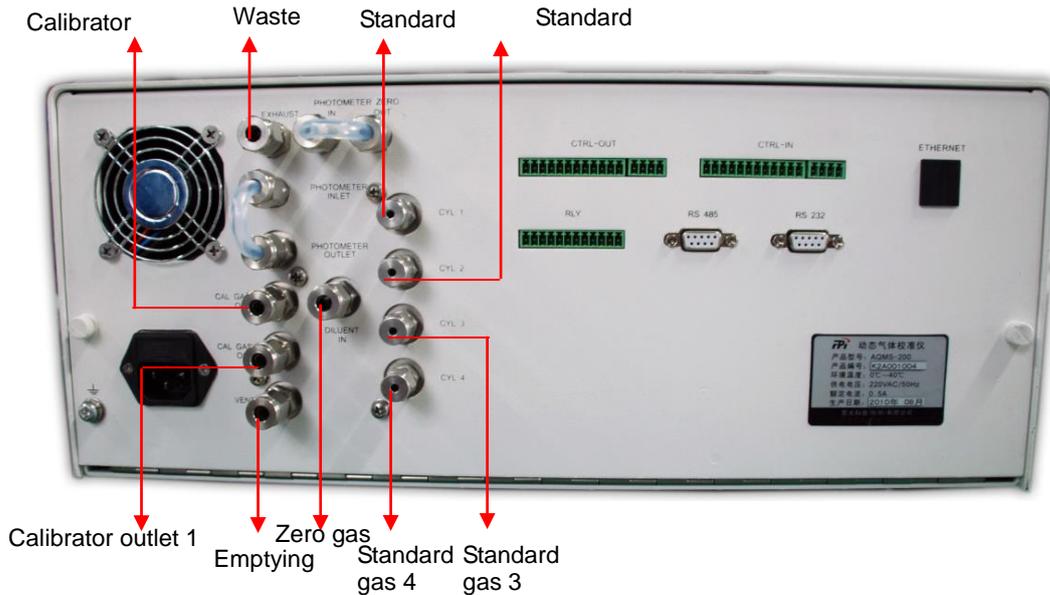


Figure 3-1 Schematic Diagram of AQMS-200 Gas Circuit Connection

3.4.2.1 Requirement for Gas Source

AQMS-200 has some requirements for zero gas, standard gas and gas purging, as described below:

- Zero gas must be dry, with dew point no higher than -20°C .
- Zero gas pressure must be kept (25~35) PSIG above and able to provide sufficient flow for AQMS-200.
- For AQMS with an ozonator, 100 sccm zero gas with continuous and stable flow shall be provided for the ozonator when it is to be started.
- If the AQMS-200 is also provided with a photometer, at least 1.1 LPM zero gas with continuous and stable flow shall provide when it is to be started.

AQMS-200 has certain requirements for standard gases, mainly including following contents:

- Standard gases are used for gas proportioning; when standard gases are used in AQMS-200, their pressure shall be kept within (25~35)PSIG; different molar masses, concentrations and proportioning ports shall be set up for different standard gases, and only after relevant settings have been done can a correct gas proportioning operation be made.
- When calculating total flow of gas proportioning, the value shall be set at 1.5 times of the actual flow to be used at least; if there are any ports not to be used in gas proportioning, the ports shall be blocked with end caps.
- Requirement for purging: Waste gas from the instrument shall be exhausted through a pipeline at least 10m long into atmosphere, and the waste gas shall be discharged into the external of operation room.

3.4.2.2 Method of Gas Circuit Connection

Use a 1/4" fluoroplastic pipe to connect the zero gas outlet of zero gas generator with the zero gas inlet of dynamic dilution calibrator; before starting the zero gas generator, its outlet pressure regulator shall be turned to the lowest position to prevent the excessive pressure bursting through internal pipelines.

When connecting standard gas, at first the secondary pressure reducing valve shall be installed to the standard gas cylinder, then the valve output connector shall be installed to the valve; 1/8" fluoroplastic pipes shall be used to connect standard gas (SO₂\NO\CO) outlets with the standard gas inlets 1, 2 and 3 of the dynamic dilution calibrator, and relevant gas ports and gas concentrations shall be set up at the dynamic dilution calibrator; after being installed, the gas circuit shall have an air tightness inspection.

3.4.3 Electrical Connection

The electrical connection includes following contents: instrument power supply, instrument grounding and communication interface. The communication interface is RS232 or RS485.

- 1.) Use a special cable to connect AQMS-200 with a power socket firmly and reliably.
- 2.) Connect the RS232 or RS485 interface of AQMS-200 to corresponding equipment if necessary.

3.4.4 Communication Link

AQMS-200 is provided with a 1.5m around 232 crossover cable, which is used to connect the instrument with data acquisition equipment; specifically, one end of the cable is connected to the 232 interface at back of AQMS-200 and the other end is connected to the data acquisition equipment, so the communication link is done.

If a 485 mode is used for connection, then a 232-485 communication conversion module is required; specifically, the pins 2, 3 and 5 of 485 port at the back of AQMS-200 correspond to the A, B and COM in 485 definition, and the interface shall be connected with the 232-485 communication conversion module according to the corresponding relation.

3.4.5 Startup and Debugging

Check whether the power supply is (100~240) V/(45~55) Hz AC; if it meets the requirement of instrument for power supply, then the power can be connected up; 1 min later, the instrument shall be powered on for inspection as per following steps:

- 1.) Regulate zero gas pressure to make it reach (29~31) PSIG.
- 2.) Turn on the AQMS-200 power switch, and the main interface program begins running.
- 3.) After being started, AQMS-200 shall be pre-heated for 30 min to enter into stable working state; operating mode or sequence program shall not be started during preheating process.
- 4.) After preheating, the main interface shall be checked whether there is any warning information; if no, AQMS can be operated, but if there is, Section 6 Alarm Information and Processing in this manual shall be followed to solve the problems.

4 Daily Maintenance and Storage

In order to ensure AQMS-200 can work accurately and reliably for a long time, it should be maintained regularly. This chapter describes the important steps in daily maintenance.

The maintainability of AQMS-200 has been sufficiently considered in designing, and users can carry out daily maintenance to the instrument by themselves.

This section will describe the following maintaining processes in detail:

- Clean the main part of instrument
- Check the air tightness of instrument
- Replace the mercury lamp of ozone spectrophotometer
- Replace the mercury lamp of ozonator
- Instrument calibration

4.1 Precautions for Use

Only the professionals with maintenance qualification are allowed to carry out the maintenance described in this chapter.

Do not leave tools inside the instrument after maintaining.

Do not use metal tools to contact or short-circuit the junctions inside the instrument.

Some operations have to be done under the running state of the instrument, thus attention shall be paid to avoiding electric shock.

4.2 Daily Maintenance

Daily patrol inspection and maintenance are very important for AQMS-200, because that can be used to analyze and prevent the faults of instruments and prolong its service life. The contents of daily patrol inspection for AQMS-200 are as follows:

- Check whether AQMS-200 is running;
- Check whether there is any warning code on the screen;
- Check whether the four pressure parameters of zero gas, standard gas, photometer and O₃ regulator are proper;
- Check whether the temperatures of ozonator lamp and photometer lamp are proper;

- Check whether the driving voltage of ozonator and photometer are proper;
- Check whether the purging mode is proper and whether there is any leakage in pipelines;
- Check whether external electric circuit, external gas circuit, internal connecting wires and buttons are changed and whether there is any hidden danger; and
- Check whether the data shown in the interface is normal or not.

4.3 Regular Maintenance

4.3.1 Clean the Main Part of Instrument

Wet cloth or dry cloth dipped in 99% alcohol can be used to scrub the main part of the instrument. It is not allowed to use organic solvent or acidic cleanser to clean the instrument.

4.3.2 Check the Air Tightness of Instrument

See 7.3.8.3 Leakage Self-check for details.

As recommended, it should be checked once every 6 months.

4.3.3 Replace the UV Lamp of Photometer

When the driving voltage of photometer is 4v, if the zero value measured by photometer is lower than 2500 mV, the UV lamp shall be replaced. The method for replacing is as follows:

- 1.) Open the instrument cover to find out the photometer;
- 2.) Find the black power supply cable that is connected with mercury lamp on the driver board of photometer, and unplug the connector;

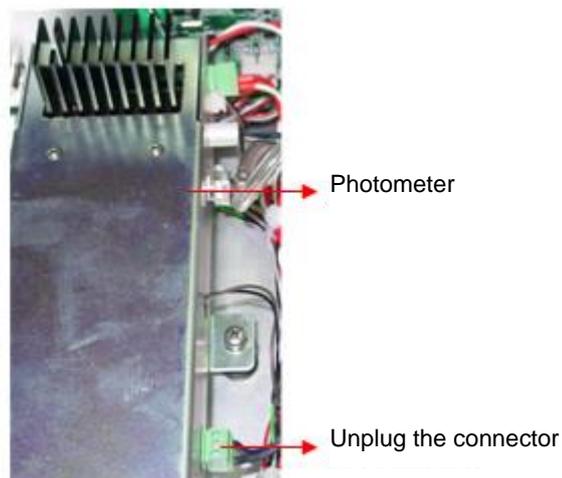


Figure 4-1 Unplug Connector

- 3.) Unscrew the four screws in the photometer cover, and take down the cover;

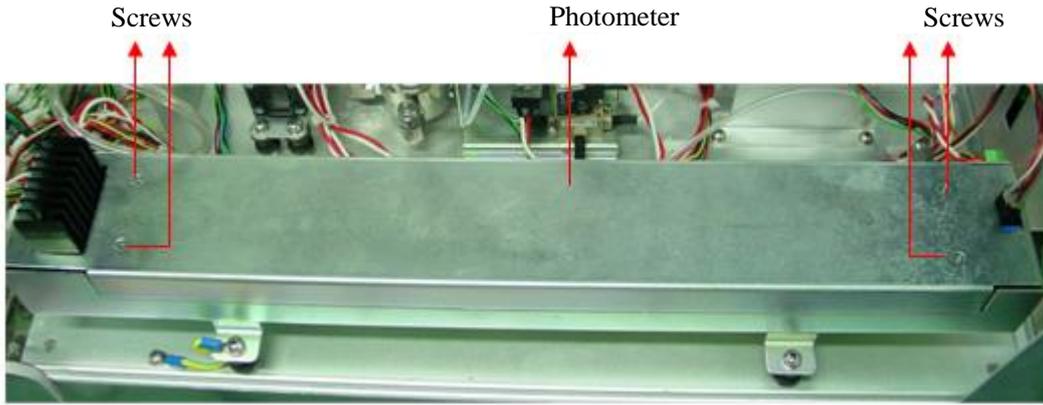


Figure 4-2 Take Out Top Cover of Photometer

4.) Find the lamp holder of mercury lamp at the pedestal close to one end of the main board; in the pedestal, there is a set screw at the position corresponding to the position at mercury lamp; unscrew a half of the screw and the lamp holder can be taken out by pulling outwards;

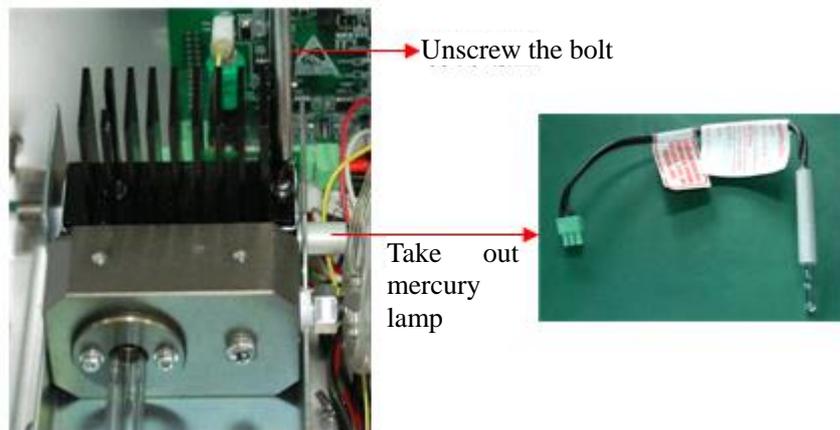


Figure 4-3 Take Out Mercury Lamp

- 5.) Push a new mercury lamp into the pedestal slowly till the lamp contacts with the bottom of the lamp holder;
- 6.) Tighten up the set screw of mercury lamp;
- 7.) Re-install the photometer cover;
- 8.) Re-install the instrument cover; and
- 9.) Carry out photometer calibration; see 7.3.8.1 Equipment Calibration for details about photometer calibration.

4.3.4 Replace the Mercury Lap of Ozonator

When the driving voltage of ozonator is 4v, if the light intensity measured is lower than 3000 mV, the UV lamp shall be replaced, and the replacing method is as follows:

- 1.) Open the instrument cover to find out the ozonator;
- 2.) Find the connector of mercury lamp power supply cable on the driver board in the front of ozonator,

and unplug the connector;

3.) There are two set screws for fixing the mercury lamp on the top of ozonator, unscrew them and take down O-rings, and take down the mercury lamp;

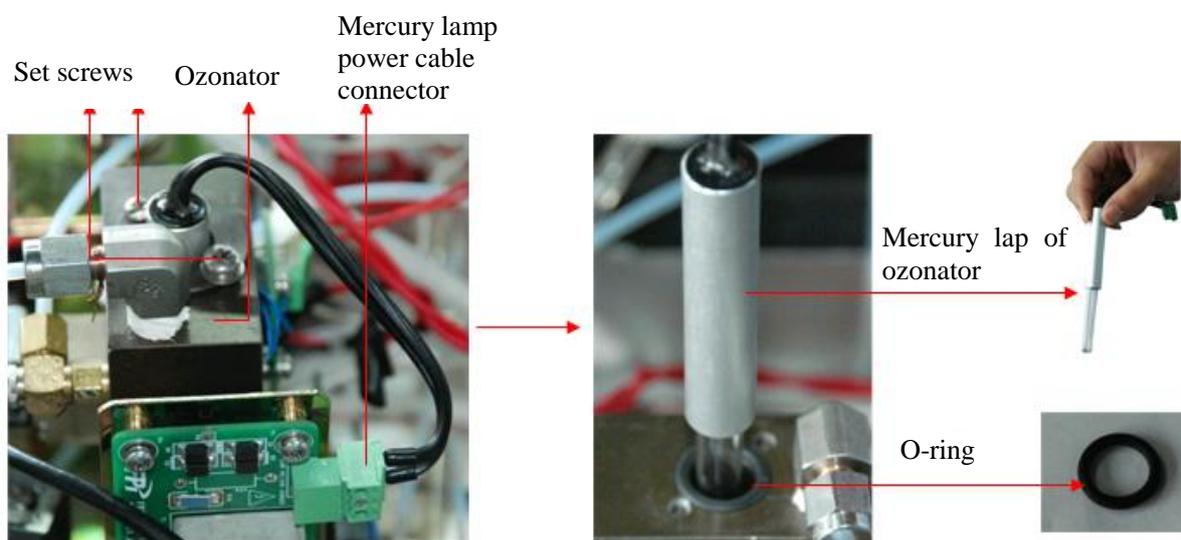


Figure 4-4 Take Down The Mercury Lap of Ozonator

4.) Push a new mercury lamp into the lamp holder of ozonator till the lamp contacts with the bottom of the lamp holder;

5.) Place the O-ring and tighten up the set screw.

6.) Re-install the instrument cover; and

7.) Carry out ozonator calibration; see 7.3.8.1 Equipment Calibration for details about ozonator calibration.

4.3.5 Instrument Calibration

See 7.3.8.1 Equipment Calibration for details.

As recommended, the instrument should be calibrated once every 6 months.

4.4 Long-time Storage

For long-time storage, the instrument shall be kept in its packing container. Attention shall be paid to the such environmental conditions as humidity, temperature and causticity for long-time storage of instrument; no pressing, no raining and no sun exposure.

Avoid placing the instrument at any locations with potential electricity interruption (such as pumps and microwave oven), high-energy magnetic field or radio interference.

5 FAQ and Troubleshooting

Attention should be paid to following aspects in troubleshooting:

- People other than professionals are not allowed to open the cover or carry out maintenance to the internal parts;
- Power supply must be cut off before opening the cover;
- The alarm information given by the instrument shall be sufficiently used for troubleshooting;
- The self-contained correcting features shall be used to correct the instrument, so as to avoid resulting in error exceeding rated value;
- Electrostatic protection measures shall be taken in implementing operation to internal structure;

Table5-1 FAQ and Troubleshooting

No.	FAQ	Troubleshooting
1	It can't be started	Check whether the power cable is connected Check whether the fuse works Test whether the input voltage is 220 V AC
2	The mode function can't be started	Check whether the preheating process is completed Check the warning code to make clear whether the code means "forced holding state" Check whether the instrument is implementing sequence program
3	Large measured deviation of ozone	Carry out leakage self-check to make sure no leakage exists in gas circuit; Check the performance of zero gas generator and replace its consumable items if necessary Check whether the flow meets the measurement requirement Check the sensors for calculating parameters relevant to ozone, such as photometer sensor, flowmeter sensor and temperature sensor in measuring chamber of photometer, and pressure sensor of photometer
4	Keys can't act	Check whether the keys are available under current mode If none key responds, then the power should be cut off to open its cover for checking the flat cable connection between the keys and the display. Long-time stopping and not continuing indicates system halted, and it should be re-started.
5	Inconformity between actual flow and target flow of standard gas	Check the port setting Check whether the gas cylinder is connected Check the pressure in gas cylinder and change the standard gas if the pressure is insufficient

No.	FAQ	Troubleshooting
		Check the mass flow controller of standard gas
5	Inconformity between actual flow and goal flow of zero gas	Check whether the zero generator is connected Check the pressure of zero generator Check the mass flow controller of zero gas
6	Nothing displayed on screen	Check whether the power cable of screen is connected Cut off the power and open its cover for checking the connection of flat cable between the display board and the display
7	Too high temperature of instrument cabinet	Confirm the ambient temperature meets the working condition required Check whether the cooling fan at the corner of instrument cabinet is working properly Check whether the ozonator temperature alarm and photometer temperature alarm sound a warning
8	Communication fault	Check whether the communication device is working properly Check whether there is anything wrong with the communication cable Restart the instrument

6 Alarm Information and Processing

Alarm code	Problem indicated	Troubleshooting
30	Abnormal actual standard gas flow	Check whether the standard gas port specified is connected Check the mass flow controller of standard gas Check whether the calibration table setting is correct
31	Abnormal actual zero gas flow	Check whether the zero gas port specified is connected Check the mass flow controller of zero gas
32	Abnormal light intensity of ozonator	Check the photoelectric sensor, mercury lamp and relevant driver electric circuit Check the state of driver board
33	Abnormal temperature of the ozonator mercury lamp	Check the mercury lamp and relevant driver electric circuit Check whether the heater of ozonator mercury lamp is connected with the main board Check the state of driver board Check whether the temperature sensor is connected properly
34	Abnormal ozone pressure at inlet	Check whether the zero gas inlet is connected with zero gas Regulate the pressure regulator manually Check the pressure sensor
35	Abnormal standard gas pressure	Check whether the standard gas source is connected or whether the pressure is regulated to a too high position Check the standard gas pressure sensor
36	Abnormal zero gas pressure	Check whether the zero gas inlet is connected with zero gas generator or whether the pressure is regulated to a too high position Check the zero gas pressure sensor
37	Abnormal temperature of instrument cabinet	Make sure the ambient temperature is within (5~40)°C Check the heat source inside the instrument cabinet Check whether the cooling is working properly Check the temperature sensor on the main board
38	Abnormal measurement of photometer	Check the driving voltage of photometer mercury lamp Check the photoelectric sensor of photometer
39	Abnormal flow of photometer	Check the flowmeter of photometer Check whether the ozone flow generated can meet the

Alarm code	Problem indicated	Troubleshooting
		requirement of photometer for measurement and output
40	Abnormal lamp temperature of photometer	Check the temperature of instrument cabinet Check temperature sensor of photometer
41	Abnormal pressure of photometer	Check the zero gas pressure sensor and photometer pressure sensor
42	Abnormal temperature of measuring chamber of photometer	Check the temperature of instrument cabinet Check the connection of sensor
43	Abnormal photometer calibration	Check all sensors of photometer and the driver electric circuit
44	Abnormality in GPTPS mode pre-set	Restart GPTPS mode
45	Abnormal communication of main board	Check communication circuits and interfaces
46	Abnormal communication of relay board	Check communication lines of relay board
47	Abnormal communication of digital board	Check communication circuit of relay board
48	Leakage Self-check fails	Check the connection of pipelines
49	Abnormal sequence program nesting	Modify the nesting levels
50	Trouble with sequence program data	Modify the sequence program
51	Errors in mode executing	Add relevant setting for standard gas
52	User setting steps or mode data fault	Modify the sequence program, mode data or standard gas setting
53	EEPROM faults	Check the electric circuit and chip of EEPROM
54	MCU AD faults	Check the sampling electric circuit and sensor
55	LTC1867 AD faults	Check the sampling electric circuit and sensor
56	RTC faults	Check the electric circuit and chip of RTC
57	Temperature sensor of ozonator faults	Manually measure the voltage of ozonator temperature sensor at test point
58	Temperature sensor of photometer faults	Manually measure the voltage of photometer temperature sensor at test point
59	The gas temperature sensor inside photometer faults	Manually measure the voltage of gas temperature sensor inside photometer at test point
60	Flow sensor of photometer faults	Manually measure the voltage of photometer flow sensor at test point
61	Temperature sensor of instrument cabinet faults	Manually measure the voltage of instrument cabinet temperature sensor at test point
62	Zero gas flow sensor faults	Manually measure the voltage of zero gas flowmeter

Alarm code	Problem indicated	Troubleshooting
		sensor at test point
63	Standard gas flow sensor faults	Manually measure the voltage of standard gas flowmeter sensor at test point
64	Pressure sensor of ozonator faults	Manually measure the voltage of ozonator at test point
65	Zero gas pressure sensor faults	Manually measure the voltage of zero gas pressure sensor at test point
66	Standard gas pressure sensor faults	Manually measure the voltage of standard gas pressure sensor at test point
67	The pressure sensor of photometer faults	Manually measure the voltage of photometer pressure sensor at test point
68	Ozonator not connected	Check whether the driver board interface of mercury lamp of ozonator is connected
69	Photometer not connected	Check whether the driver board interface of mercury lamp of photometer is connected
70	Photoelectric sensor of ozonator faults	Manually measure the voltage of ozonator's photoelectric sensor at test point
71	Photoelectric sensor of photometer faults	Manually measure the voltage of photometer's photoelectric sensor at test point

7 Software Operation

7.1 Interface Overview

7.1.1 Operation Panel

The operation panel of dynamic dilution calibrator AQMS-200 adopt 800×480 pixel, 7 inch LCD screen.



Figure 7-1 Operation Panel Interface

7.1.2 Operation Environment

Table 7-1 Software operation environment

Environment	Requirement
Hardware	RAM: Above 512M CPU: CORTEX-A8 Screen Resolution: 800*480
Software	Operation System: WINCE 7.0 Runtime Library: .NET Compact Framework V2.0

AQMS-200 adopts simple and convenient menu-typed interface. Main interface contain Main display interface, Main setting interface, Gas setting, Mode control, Program Setting, Program Control, Alarm Information, System Information, Communication, Maintenance. The whole menu structure is simple, clear and easy for operation.

Table 7-2 AQMS-200 menu structure

Function Category	Subfunction
R_FUNC_1: Home page function	R_FUNC_1.1 Flow chart
	R_FUNC_1.2 Real time parameter
R_FUNC_2: System calibration	R_FUNC_2.1 Pressure calibration
	R_FUNC_2.2 Flow meter calibration
	R_FUNC_2.3 Generator calibration
	R_FUNC_2.4 Photometer calibration
R_FUNC_3: Gas setting	R_FUNC_3.1 Cylinder setting
	R_FUNC_3.2 Gas type setting
R_FUNC_4: Mode control	R_FUNC_4.1 Auto generation
	R_FUNC_4.2 Zero gas generation
	R_FUNC_4.3 Manual generation
	R_FUNC_4.4 Instrument purge
	R_FUNC_4.5 Pre-set titration
	R_FUNC_4.6 Gas-phase titration
R_FUNC_5: Program setting	R_FUNC_5.3 Program setting
	R_FUNC_5.4 Procedure setting
R_FUNC_6: Alarm information	R_FUNC_6.1 Current alarm
R_FUNC_7: System setting	R_FUNC_7.1 System information
	R_FUNC_7.2 Communication setting
	R_FUNC_7.3 Parameter setting
	R_FUNC_7.4 System time
	R_FUNC_7.5 User setting
	R_FUNC_7.6 System diagnose
R_FUNC_8: Maintenance	R_FUNC_8.1 Leakage test
	R_FUNC_8.2 Realy
	R_FUNC_8.3 Com port
	R_FUNC_8.4 Mercury light
	R_FUNC_8.5 Flowmeter
	R_FUNC_8.6 Driving voltage

7.2 Main Display Interface

"Main display interface" refers to the interface for carrying out normal work after the system is started and self-checked. "Main display interface" is used to display main information of system, as shown in Figure 7-2.

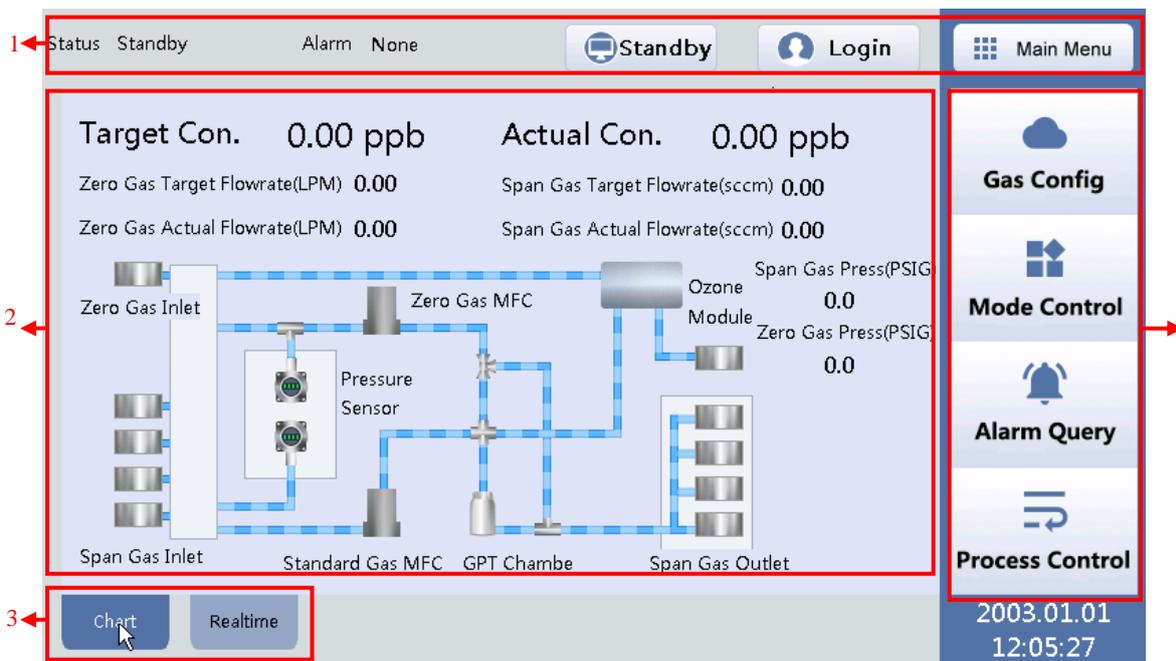


Figure 7-2 AQMS-200 Main Display Interface

Table7-3 Description of Main Display Interface

No.	Name	Function
1	Title bar	To show the software name, time and date, and instrument cabinet temperature.
2	Information display area	To show current information of instrument, and information has following meanings: <ul style="list-style-type: none"> ● Target flow of standard gas: The flow value set for the flowmeter of standard gas to reach. ● Actual flow of standard gas: The actual flow value measured by the flowmeter of standard gas. ● Standard gas pressure: The standard gas pressure value measured by the standard gas pressure sensor. ● Zero gas pressure: The zero gas pressure value measured by the zero gas pressure sensor. ● Ozone flow: Flow value of ozone generated by ozonator; as "check flow" function is used by the system, the value is constant, i.e., 0.105 LPM. ● Flow of photometer: The flow value of gas extracted by the photometer, and it is measured by the flow sensor at the photometer outlet. ● Pressure of photometer: It is the pressure value measured by the pressure sensor at outlet of photometer. ● Temperature of photometer gas: The temperature value measured by the temperature sensor at the measuring chamber inside photometer.
3	Status bar	To show the information about system status and mode.
4	Shortcut key area	There are 4 shortcut keys, including mode, sequence program, diagnosis and screen lock, in the main display interface. Press down the functional key at the bottom, then enter the interface of functional menu.

7.3 Main Setting Interface

When the user wants to change the settings of AQMS-200, press "main menu" in "main display interface", the system will go to main setting interface as shown in Figure 7-3

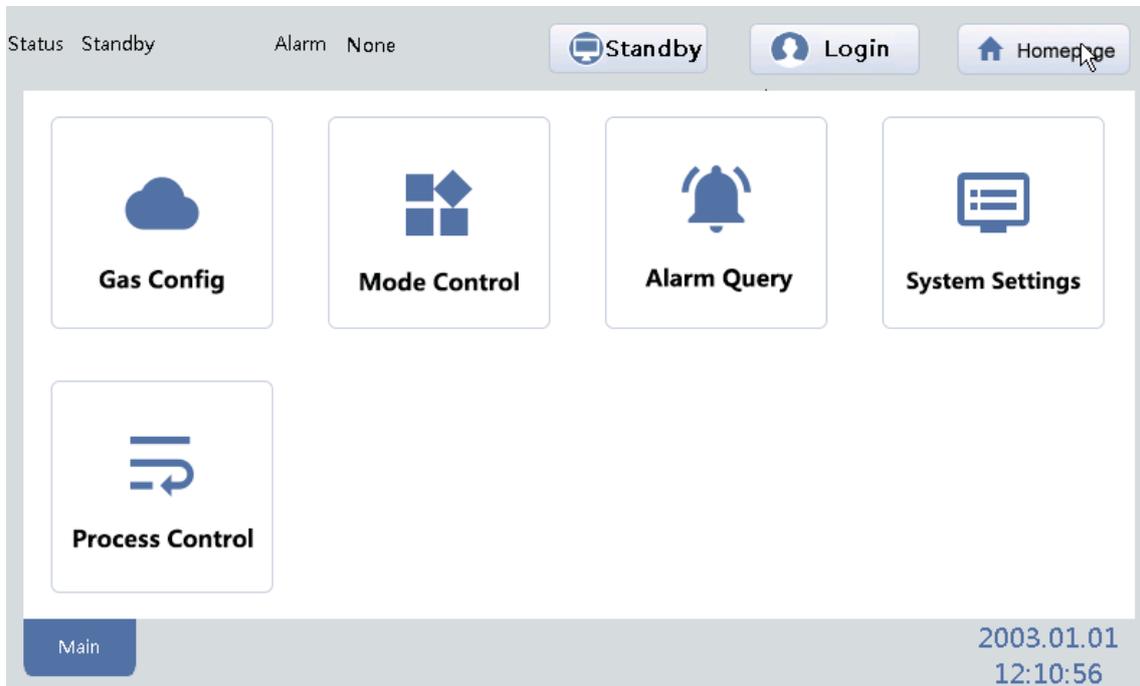


Figure 7-3 Main Setting Interface

7.3.1 Gas Setting

"Gas setting interface" is the first option in "main setting interface", as shown in Figure 7-4.

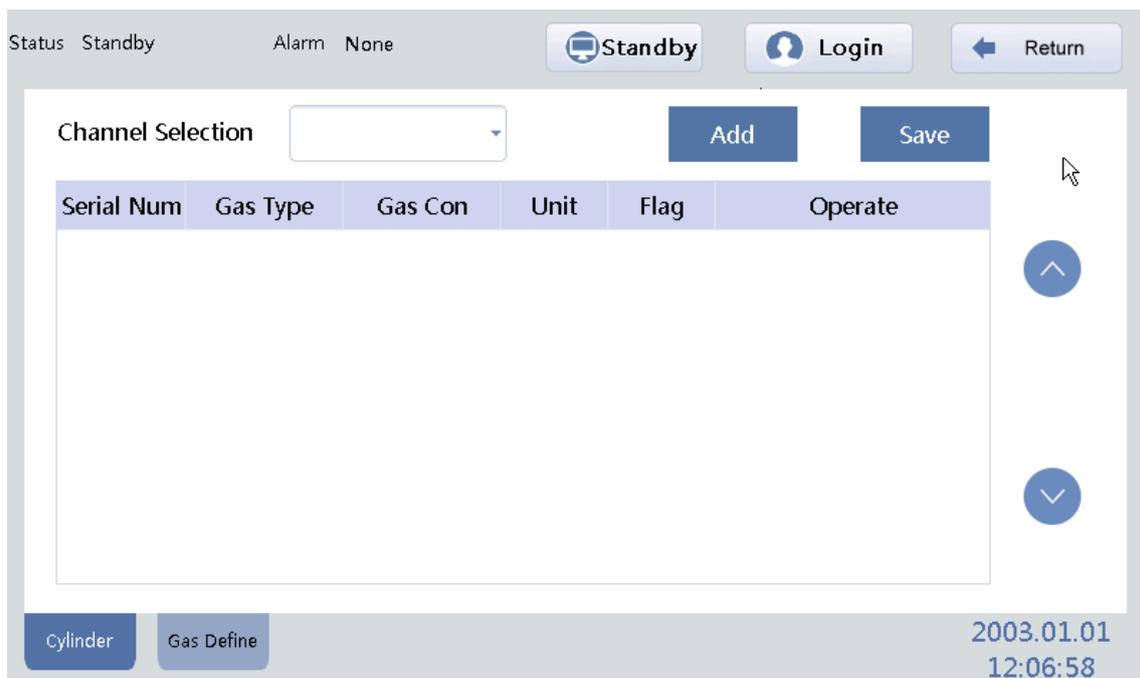


Figure 7-4 Gas Setting

7.3.1.1 Cylinder Setting

Cylinder setting menu is used to set up relevant parameters of standard gas at inlet, including information about type, concentration and unit of standard gas, as shown in Figure 7-5.

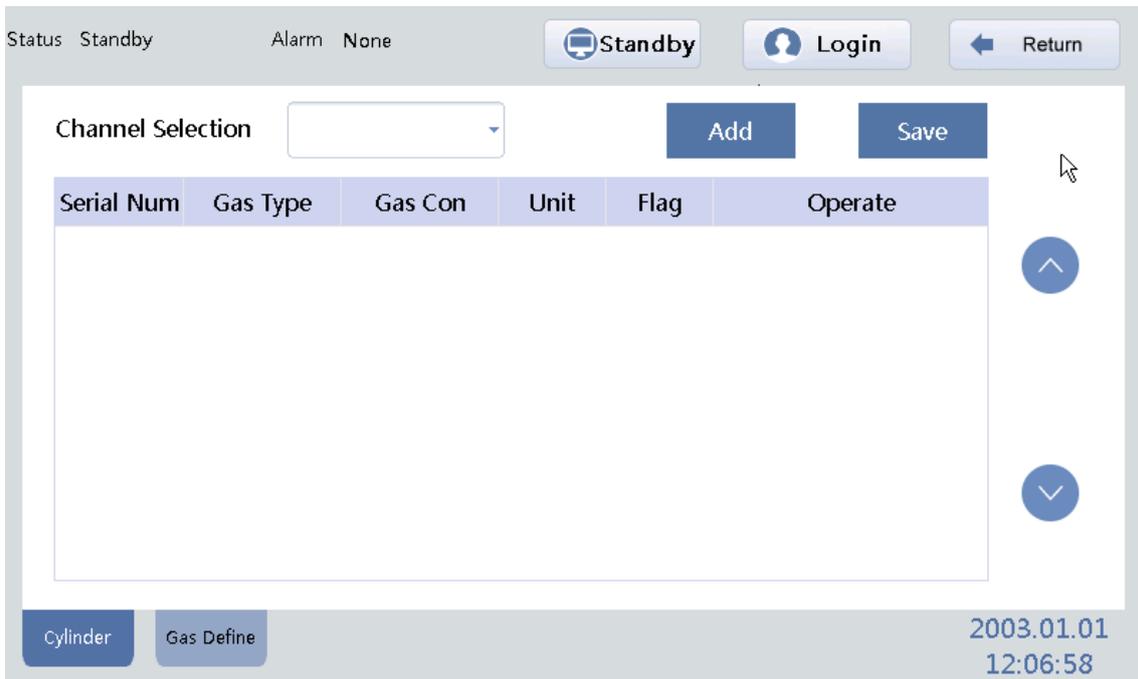


Figure 7-5 Cylinder Setting

AQMS-200 has 4 gas inlets, corresponding to the 4 ports shown above, and the user can set up the 4 ports according to actual situation. This section will take Port 1 as an example to specify the method for cylinder setting.

 **NOTE:**

The method for setting other ports are the same with Port 1, thus omitted.

Choose channel 1 and press “add” to enter Port-1 cylinder setting interface.

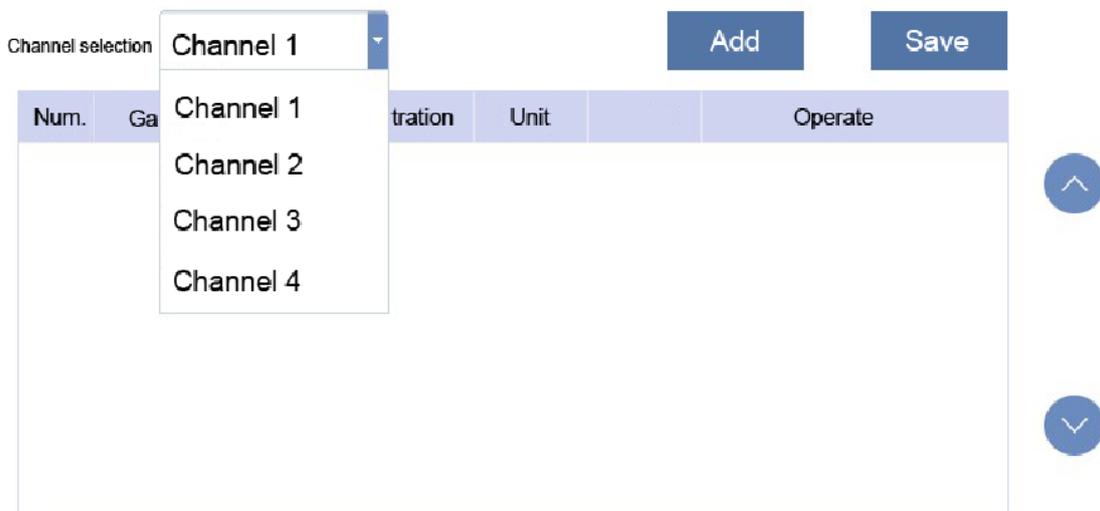


Figure 7-6 Choose Channel

Cylinder gas

Type SO2

Unit ppb

Concentration 1.00

Enable ON OFF

Confirm Cancel

Figure 7-7 Port-1 Cylinder Setting (No Gas Setting)

In the gas setting menu, edit gas type, gas concentration, gas unit in corresponding area.

Cylinder gas

Type SO2

Unit SO2

Concentration H2S

Enable N2O

Confirm NO

NO2

NH3

Figure 7-8 Gas Type Setting



Figure 7-9 Gas Concentration Setting

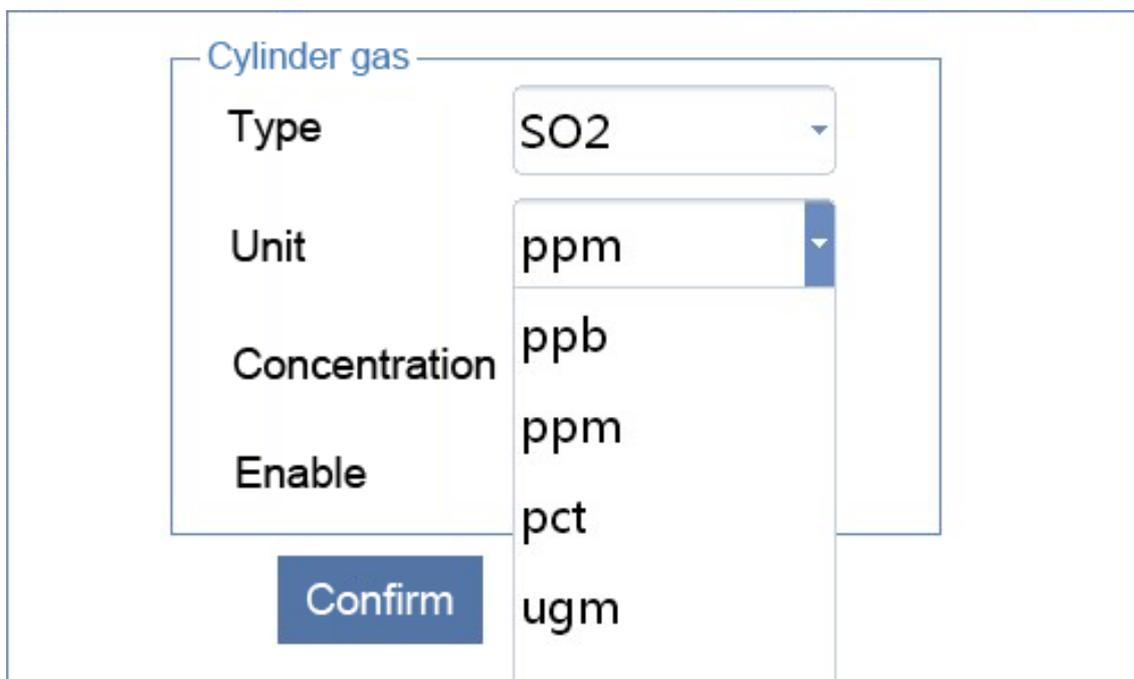


Figure 7-10 Gas Unit Setting Interface

User can add more gases according to actual requirement. The existed gas can be delete and edit.

 **NOTE:**

1. Maximum 10 gas for each channel.
 2. Same gas cannot be set in the same channel and different channel should have different gas.
-

7.3.1.2 User Definition of Gas

User definition of gas is used for setting gas parameters, including gas name, molar mass, and use the gas or not, as shown in Figure 7-12.

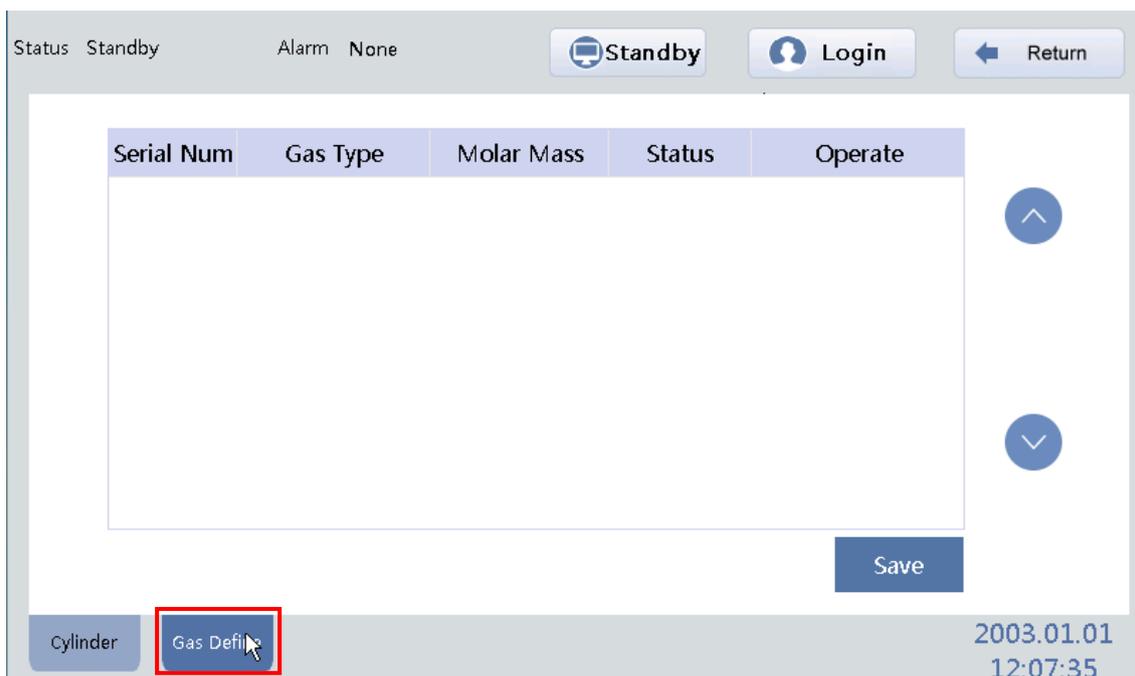


Figure 7-11 User Definition of Gas

For example: Set parameters for SO₂ having molar mass of 64 and make the gas setting effective.

 **NOTES:**

In setting user definition of gas, the user can set up 15 gases, in which the first 10 gases that have been set up before leaving factory can't be set again, and the last 5 gases with names of USER1-USER5 can be re-set for new names.

7.3.2 Mode Control

"Mode control interface" is the second option in "main setting interface", as shown in Figure 7-14. The system provides 6 modes optional, i.e., automatic generation, manual generation, instrument purging, standby, gas-phase titration and pre-set titration. User can touch corresponding tab bar to enter the next menu, or press "Esc" to go back "main setting interface".

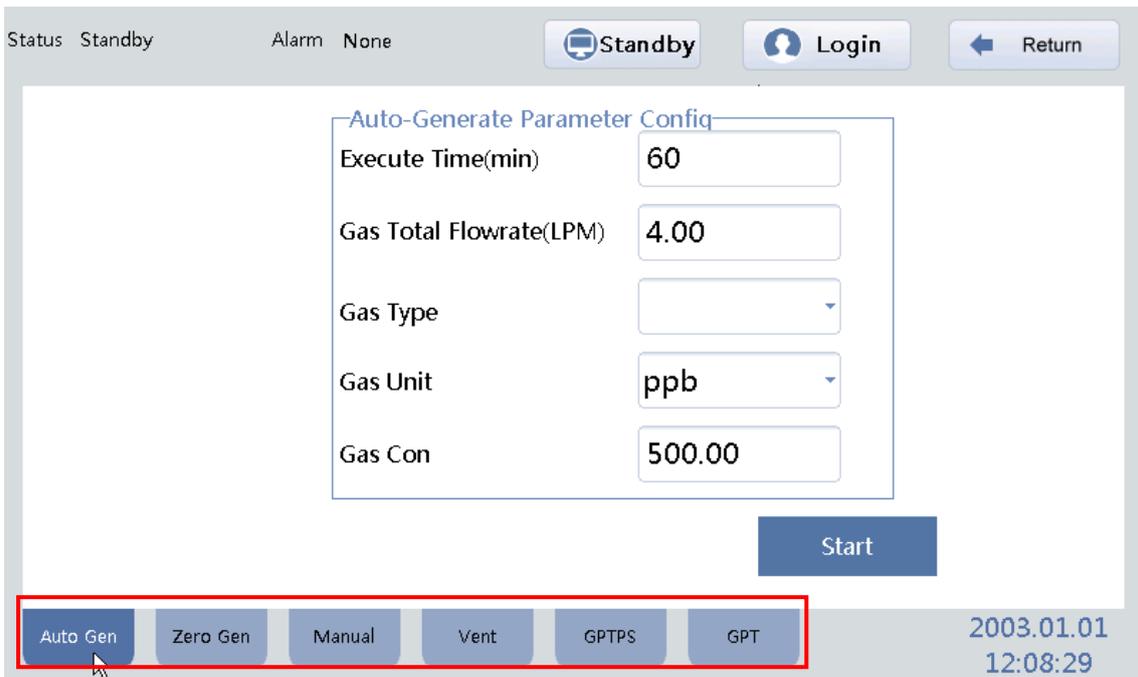


Figure 7-12 Mode Control

7.3.2.1 Automatic Generation

As shown in Figure 7-15, the automatic generation interface is used to make the generation mode automatic and to set relevant parameter for automatic mode.

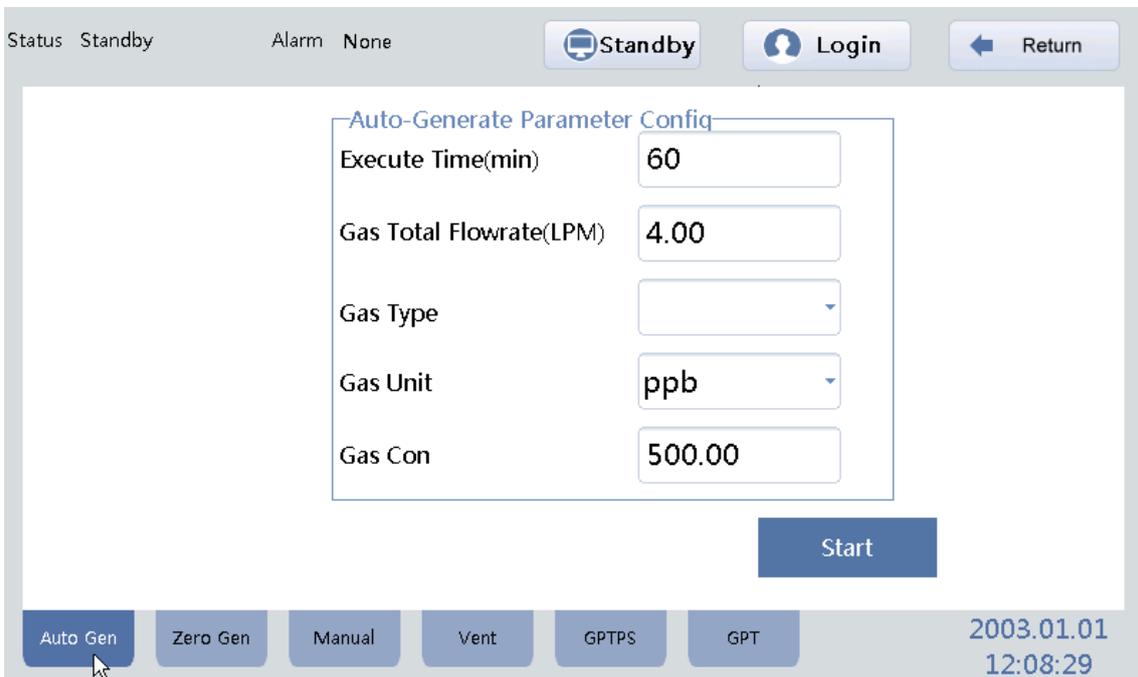


Figure 7-13 Automatic Generation Mode

After finish setting, press “Esc” to go back to the main menu to check the gas generation information.

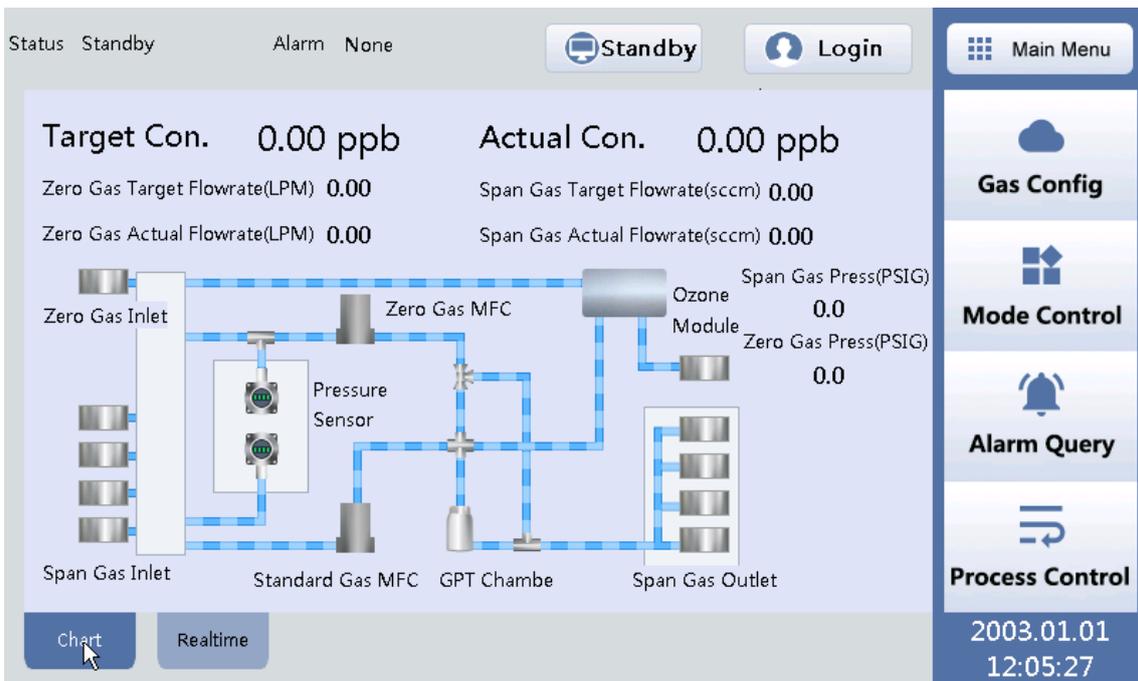


Figure 7-14 Flow chart under Automatic Generation Mode

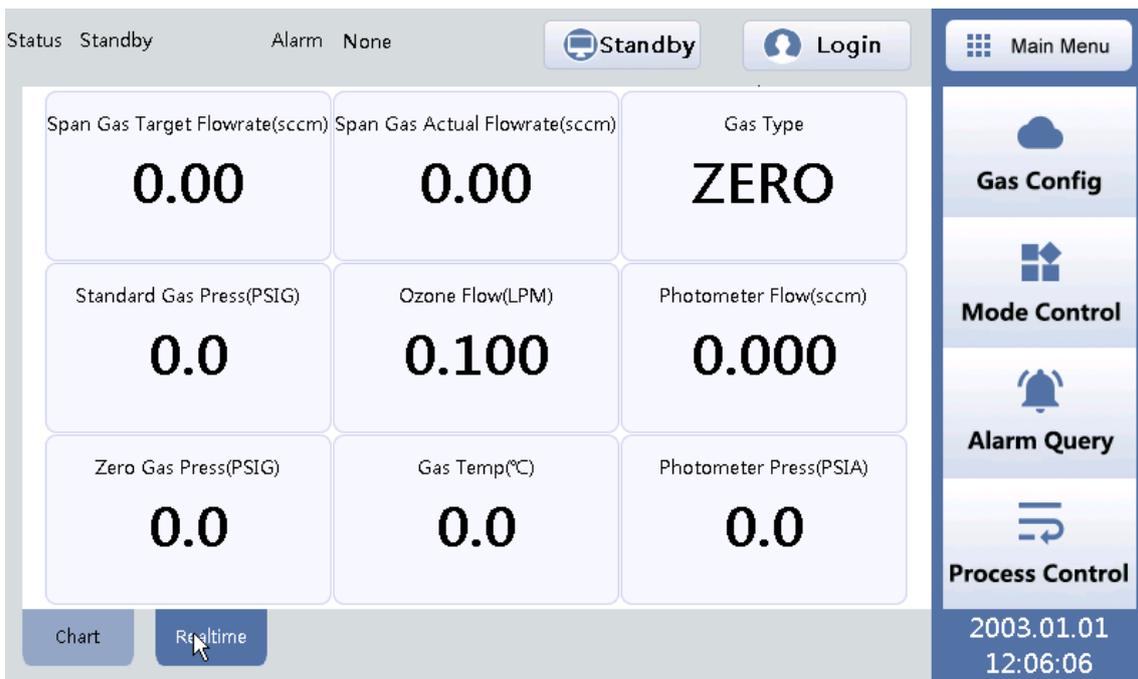


Figure 7-15 Main Display Interface under Automatic Generation Mode

7.3.2.2 Manual Generation

As shown in the figure below, the manual generation interface is used to make the generation mode manual and to set relevant parameter for manual mode.

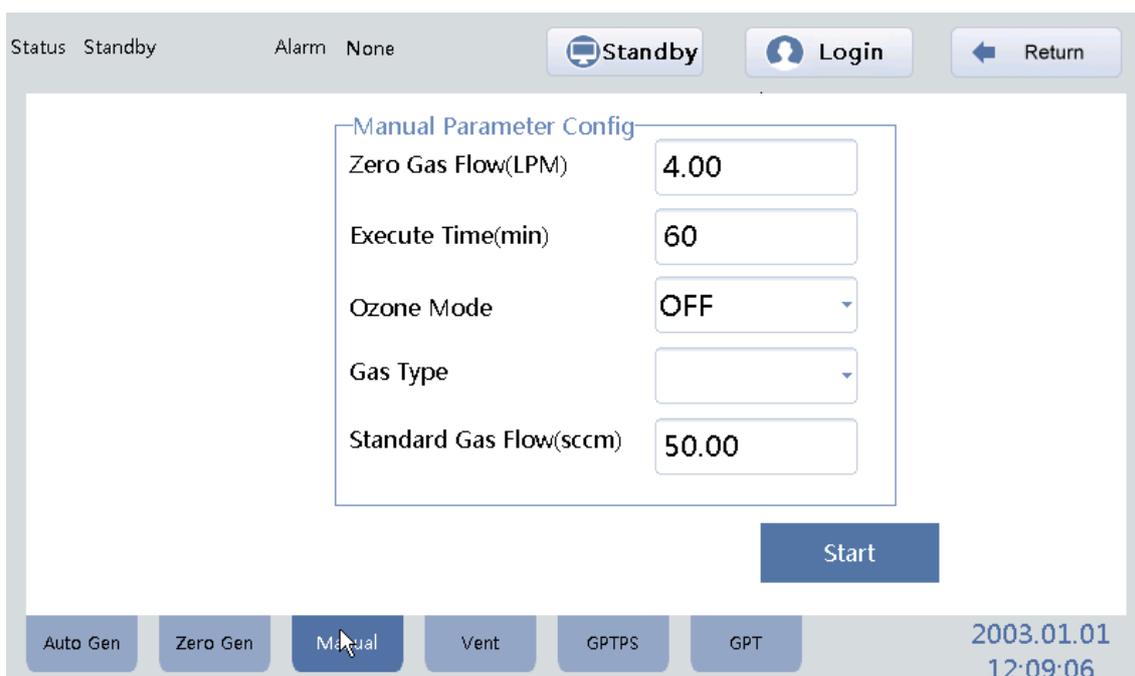


Figure 7-16 Manual Generation Mode

For example: Use manual generation mode to blend 50 μ mol/mol (ppm) SO₂, requiring 50 sccm standard gas flow, 6 LPM zero gas flow, and 60 min execution time. The method for setting is as follows:

Touch zero gas flow rate for the required flow rate setting.

Press start, the corresponding standard gas with specified concentration will be generated.

Ozone production mode includes two options, i.e., OFF and BENCH, having following meanings:

- OFF: No ozone will be produced under this mode.
- BENCH: Photometer feedback mode, under which the driver voltage of ozonator will be adjusted according to the value measured by ozone spectrophotometer.

7.3.2.3 Instrument Purging

Instrument purging mode is used to start the instrument for purging and to set up relevant parameters for instrument purging, as shown below.



Figure 7-17 Instrument Purging Mode Setting Interface

7.3.2.4 Zero Gas Generation

Zero gas generation mode is used to generate zero gas, as shown below.

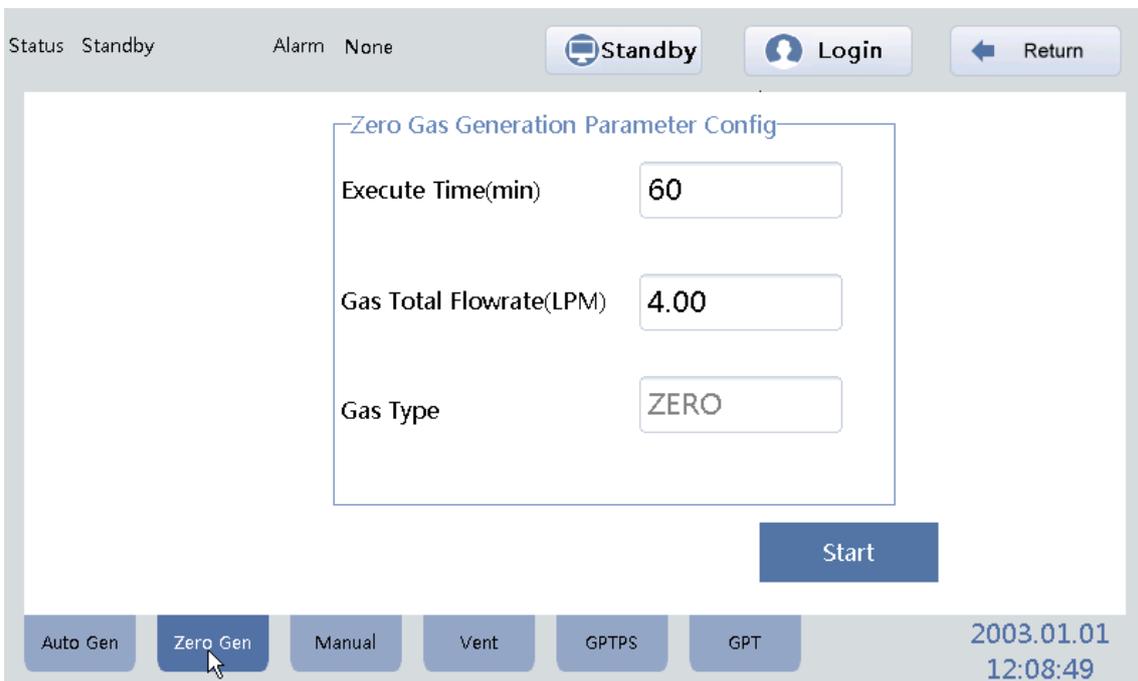


Figure 7-18 Zero Gas Generation Mode

7.3.2.5 Gas-phase Titration

Gas-phase titration interface is used to start gas-phase titration mode and set up parameters relevant to gas-phase titration; its interface is shown as follows.

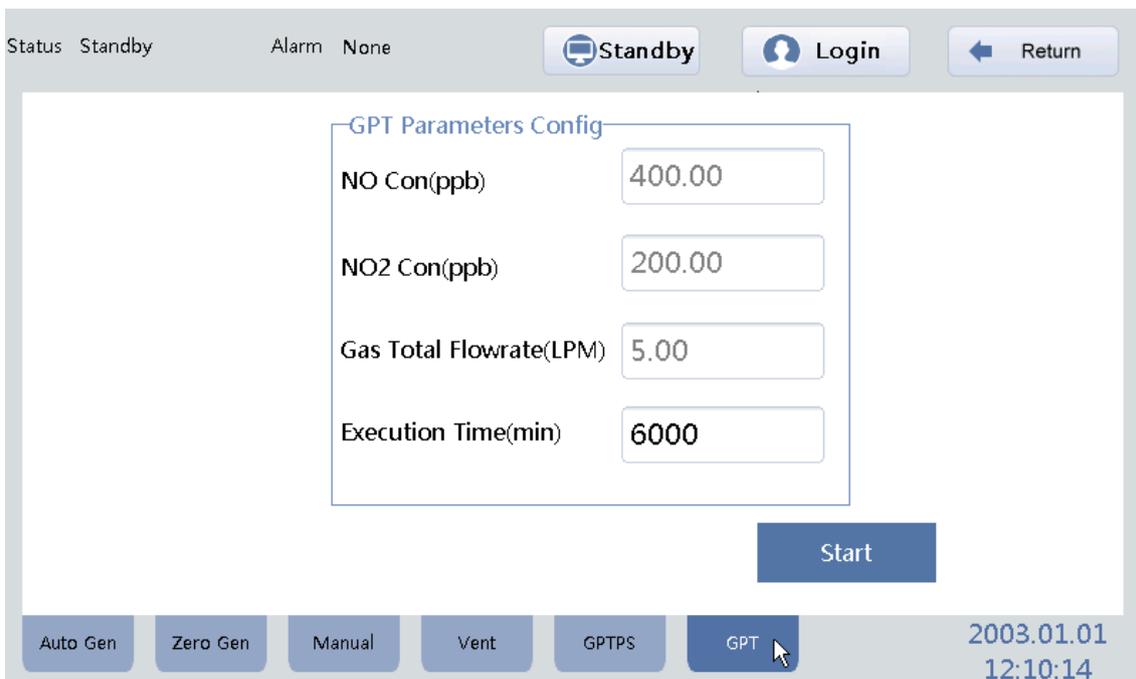


Figure 7-19 Gas-phase Titration Mode

For example: Set the execution time as 30 min, and other parameters including NO₂ concentration, NO concentration, and total gas flow are only shown in this interface and they can be set up in pre-set titration interface. After setting, press start to start gas-phase titration mode.

7.3.2.6 Pre-set Titration

Pre-set Titration interface is used to start pre-set titration mode and set parameters relevant to pre-set titration, and its interface is shown as follows.

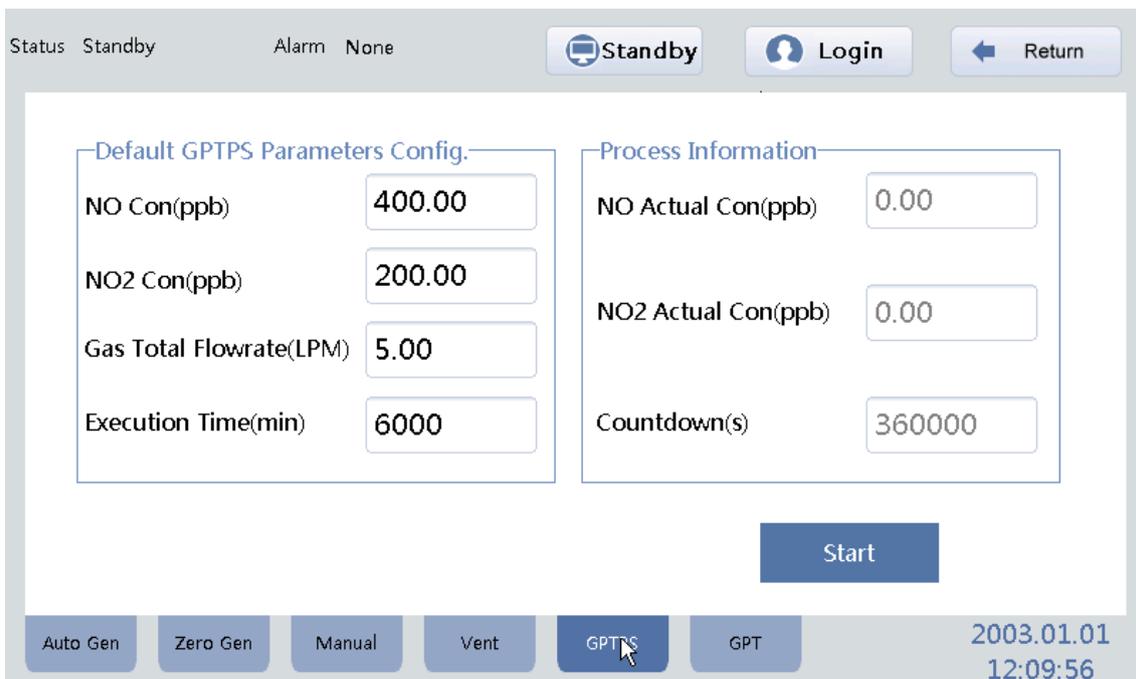


Figure 7-20 Pre-set Titration Mode

After setting, the prompt bar will pop up, then you can start the gas-phase titration mode.

 **NOTE:**

Pre-set titration will be shown by two steps, i.e., ozone spectrophotometer adjusting and pre-setting; the execution time shown in Figure 7-41 refers to pre-set titration time, while ozone spectrophotometer adjustment will last 3 to 25 min in general.

7.3.3 Sequence Program Control

"Sequence program control interface" is the third option in "main setting interface", as shown in Figure 7-42. Sequence program control interface is used to start the program that has been set up in section 7.3.4 Sequence Program Setting.

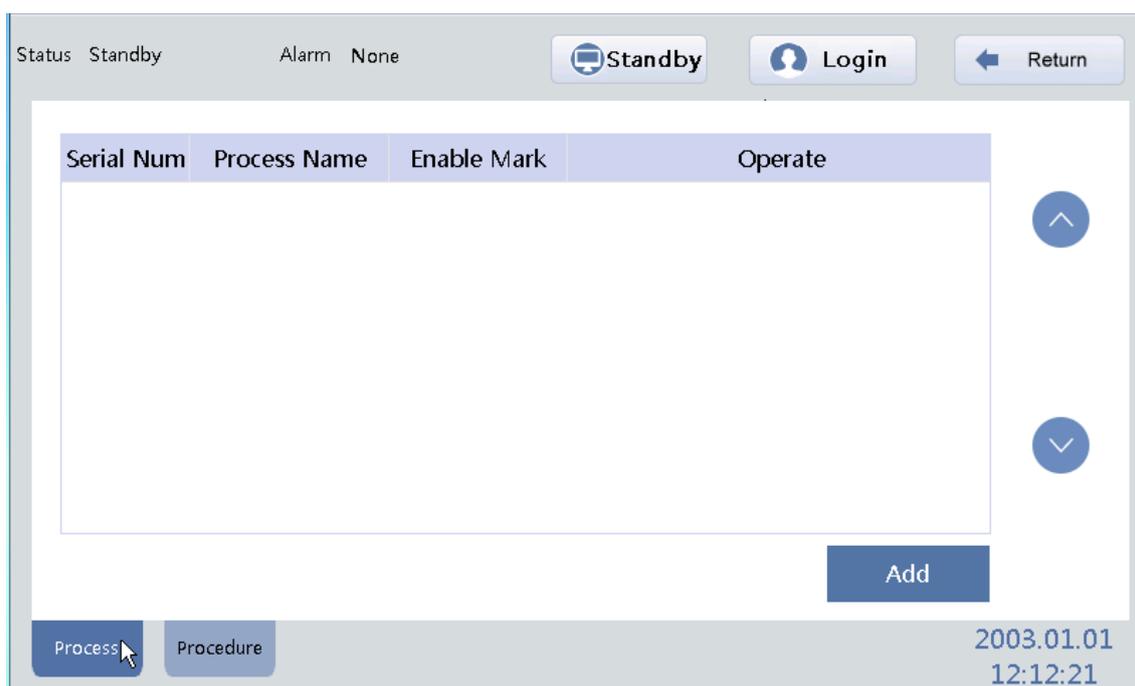


Figure 7-21 Sequence Program Control Interface

 **CAUTION:**

The sequence program of instrument can only be started under standby mode; please enter standby mode before starting corresponding program for sequence control.

For example, to start a sequence program named "MCU09", the method is as follows:

7.3.3.1 Sequence program setting

User can add, delete and modify the sequence program in the sequence program setting interface.

Touch add to add an new program.

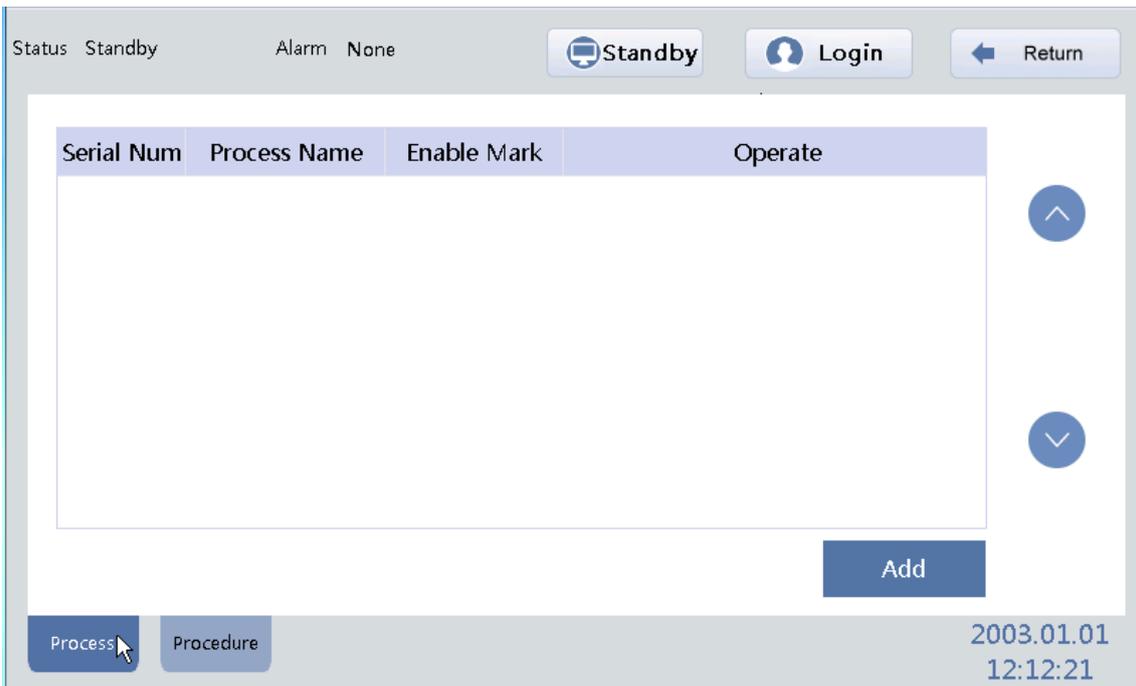


Figure 7-22 Add program interface

Setup program name, execution times, report mode, cycle mode, enable flag, digital input, digital output in the pop up bar. After that, an new program will be generated.

Press confirm, the new program will be added successfully.

After program added, press "procedure setting" to set the detailed procedures. Choose completed program in the program selection area.

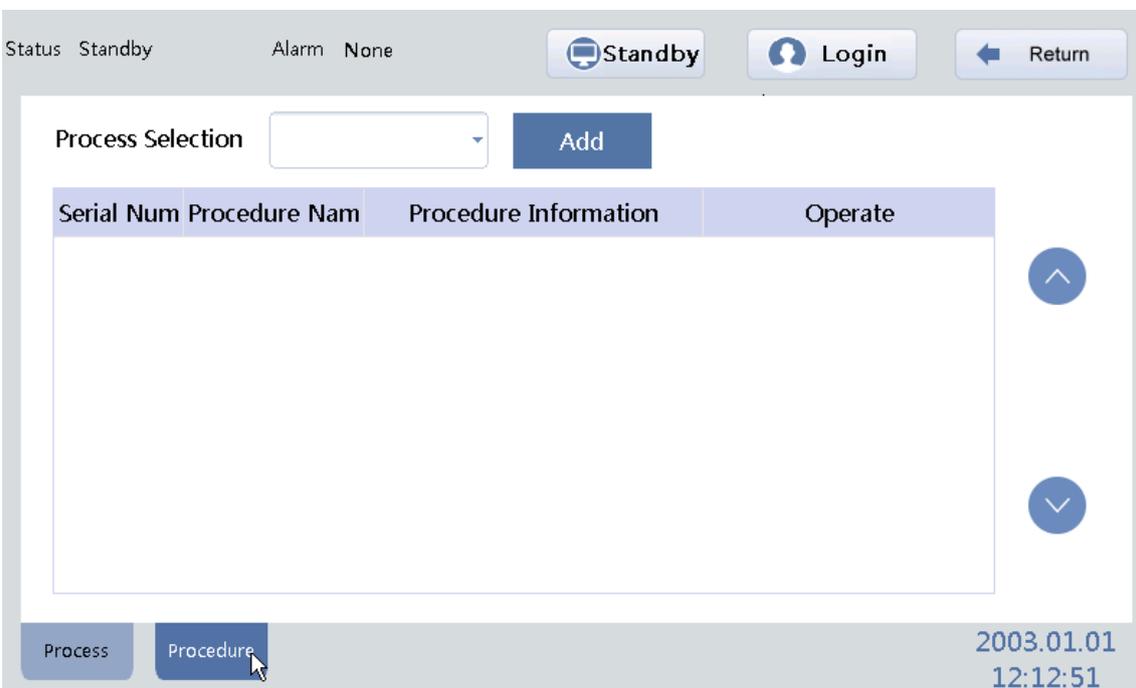


Figure 7-23 Choose program setting

7.3.3.2 Start program.

Press program setting, choose the program need to start and press start button.

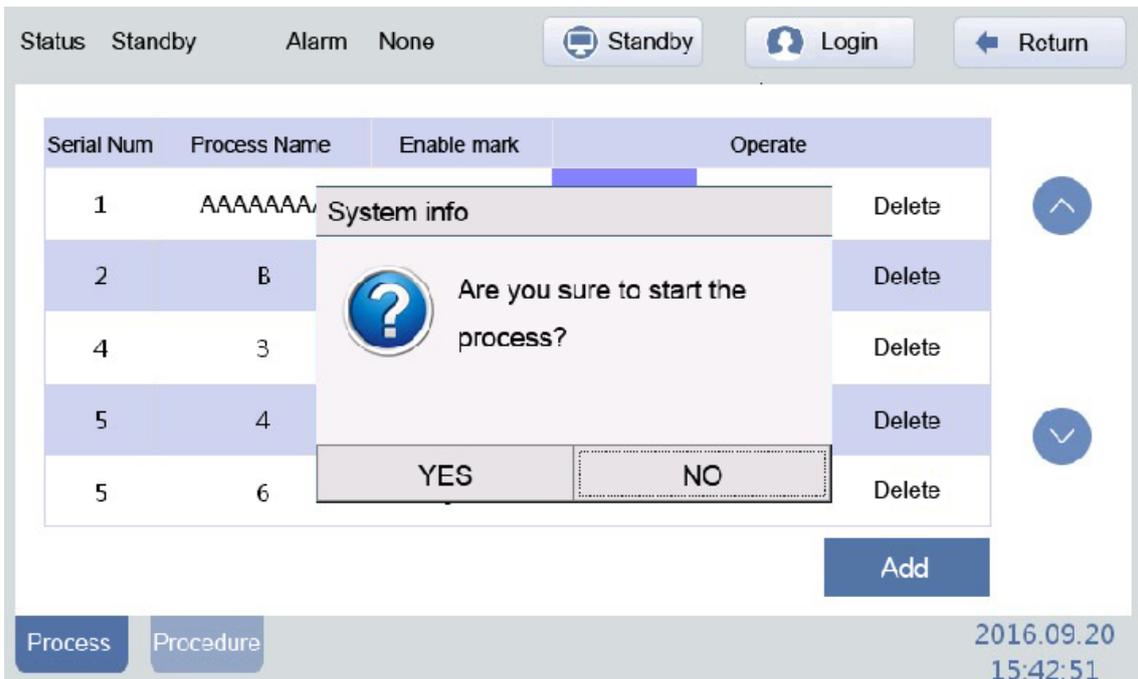


Figure 7-24 Start program

Press Yes, program will be running.

7.3.4 Alarm Information

"Alarm information setting interface" is the fifth option in "main setting interface", as shown in the figure below.

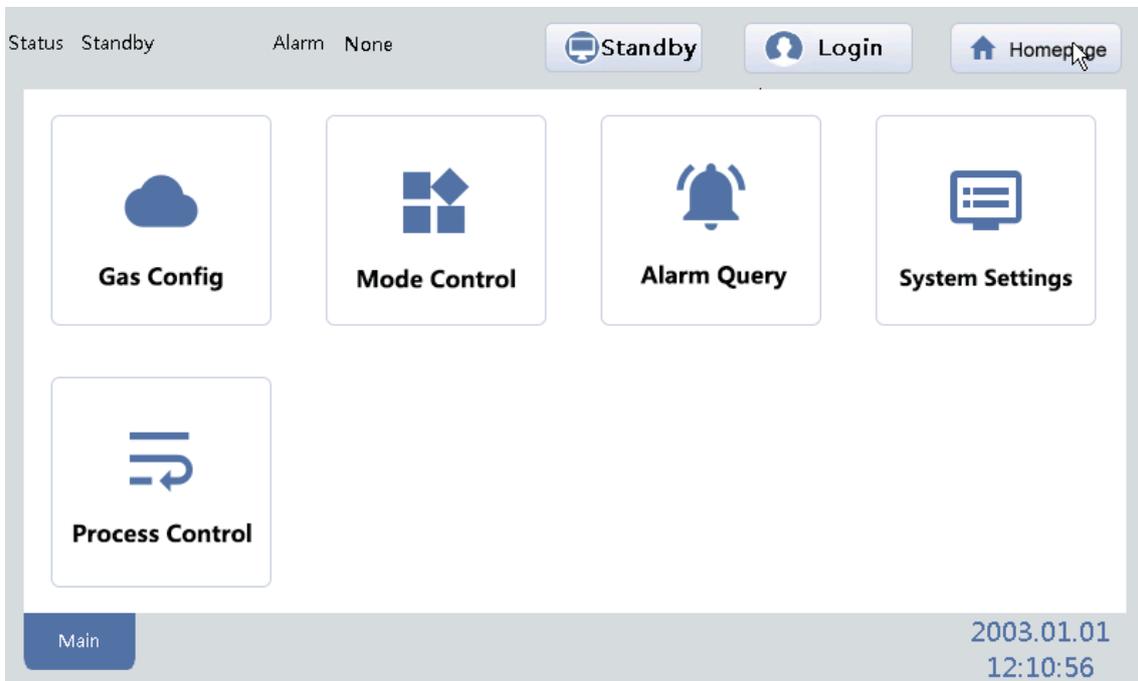


Figure 7-25 Alarm Information

In alarm setting interface, the alarm code and alarm information can be viewed; press "Esc" to quit the alarm information interface.

You can also find the shortcut button in main display interface. Alarm code and detailed alarm

information can be checked.

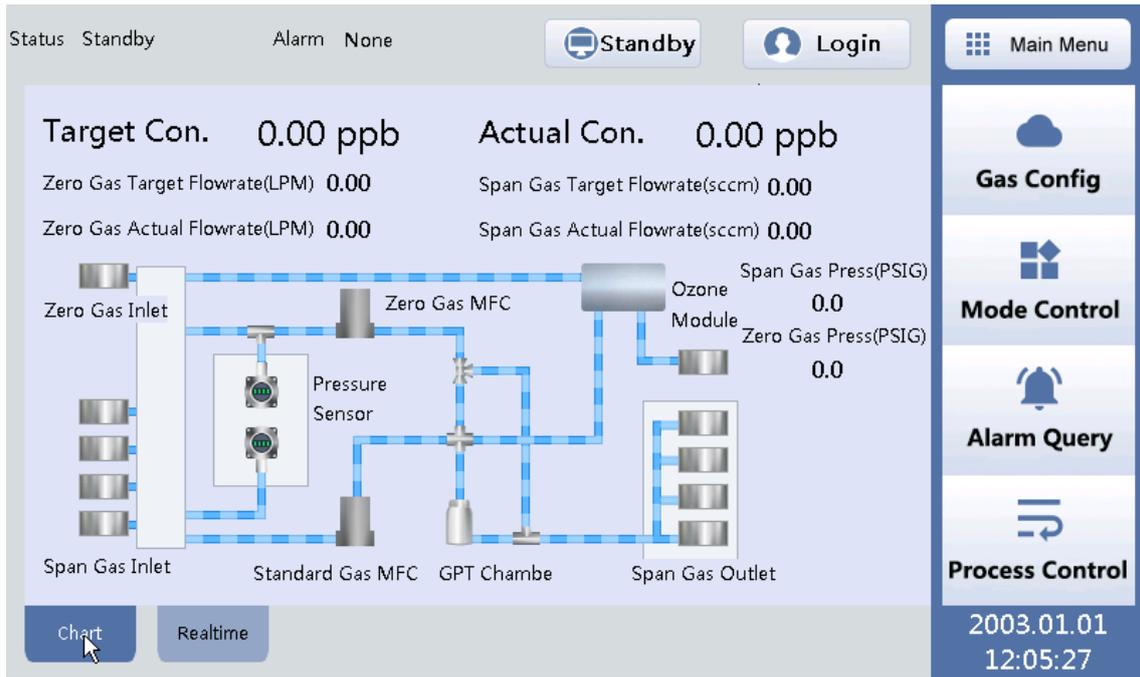


Figure 7-26 Shortcut alarm query in main interface

7.3.5 System Information

"System information interface" is the fourth option in "main setting interface", system information and system diagnose can be found as shown in the figure below.

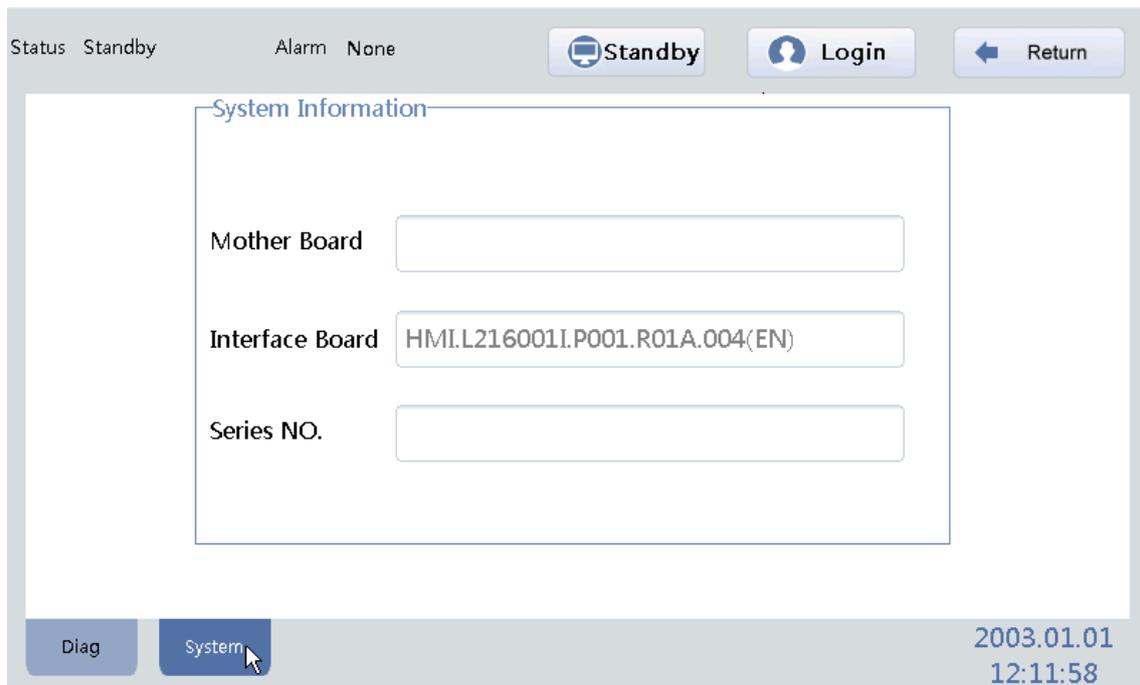


Figure 7-27 System Information

System information interface show software version, main board version and software compiling time.

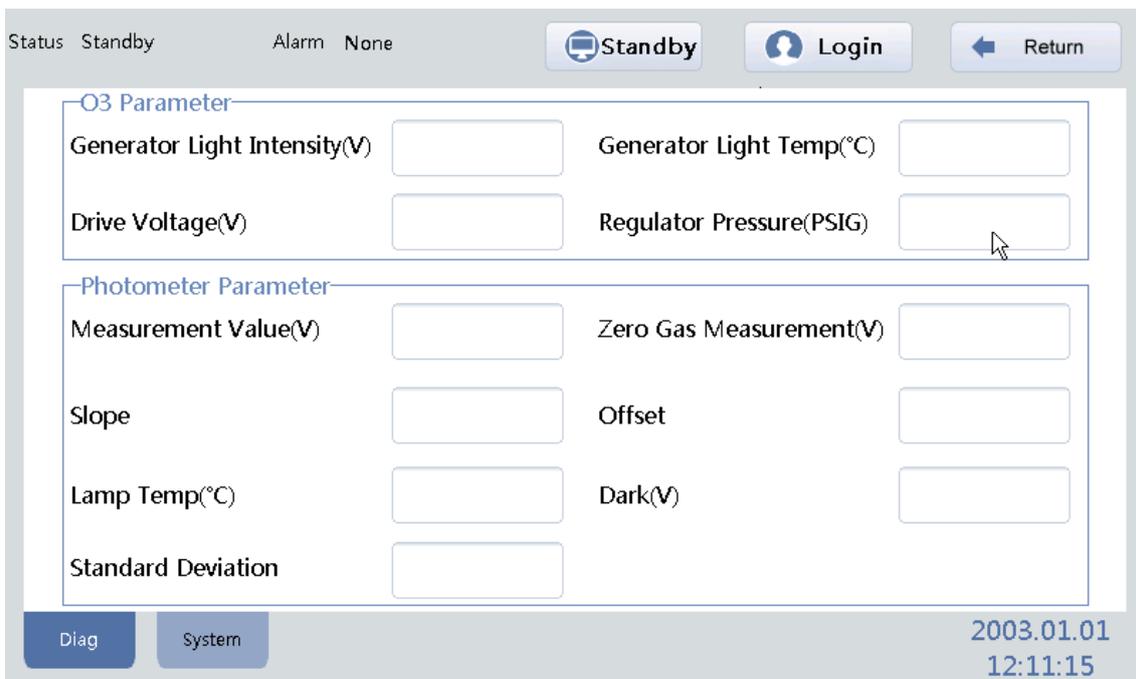


Figure 7-28 System diagnose

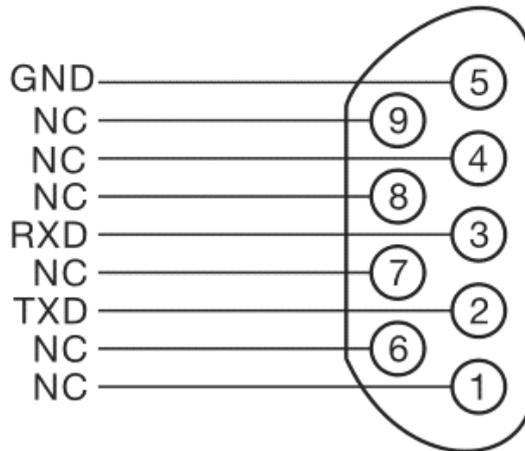
System diagnose interface show ozone generator and photometer parameters.

7.3.6 Communication Setting

The default communication method are 232 baud rate, 485 baud rate and baud rate are all 57600.

Appendix I RS232 Communication Interface

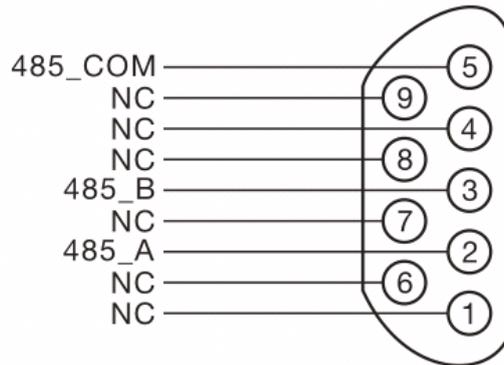
It requires a DB9 connector (as shown below), of which the pin definitions are shown in the table below:



Pin No.	Name	Clarification
1	NC	-
2	TXD	Transmitting end of RS232
3	RXD	Receiving end of RS232
4	NC	-
5	GND	RS232 grounding
6	NC	-
7	NC	-
8	NC	-
9	NC	-

Appendix I RS485 Communication Interface

It requires a DB9 connector (as shown below), of which the pin definitions are shown in the table below:



Pin No.	Name	Clarification
1	NC	-
2	485_A	485 Bus A
3	485_B	485 Bus B
4	NC	-
5	485_COM	485 Bus COM
6	NC	-
7	NC	-
8	NC	-
9	NC	-