RT-200C Plus
Chemistry Analyzer
Service Manual

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CONTENT

1 Introduction

1.1 Operation Principle and Application Scope

The instrument adopts operation principle of optical colorimetry, applicable to clinic conventional bio-chemical test. The equipment has no energy output, and is free from the risk of overheat and excess radiation. The only precaution is given to the mechanic movement risk and electric shock: It is required to cut off the power supply and turn off the main system when dismantling the housing for repair or for other reasons.

Rayto 200C Plus is simple in operation, having unique screen interface and perfect information communication system, being an ideal analysis instrument of the clinical chemistry laboratory.

Rayto 200 C Plus system is able to carry out the following operations:

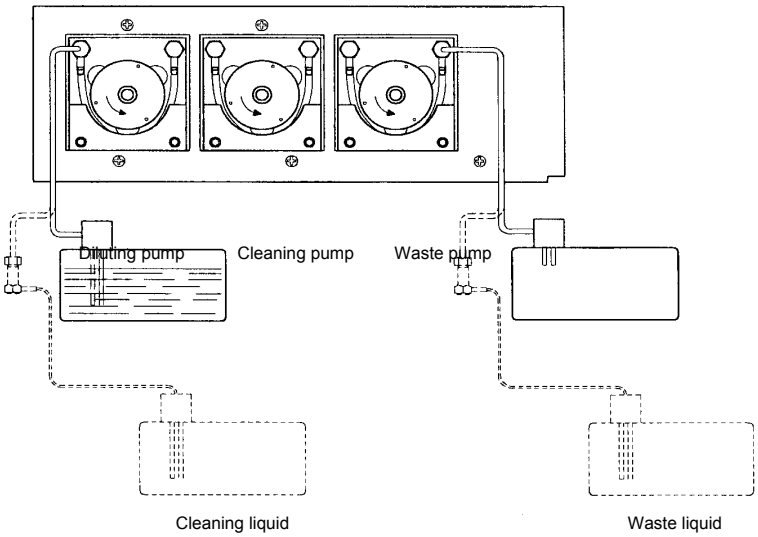
1. Powerful software function, with a routine work table, an STAT work table, calibration and quality control work table. In addition, it is able to create 9 independent and different work tables, with each work table able to accept 60 samples (Note: The STAT work table accepts 30 samples only).
2. The instrument contains two reagent frames, total 36 reagent positions, with the single reagent and the dual reagent position combined optionally.
3. It displays and prints result in different ways, including the patient's report and information storage.
4. It is applicable in the End Point, Kinetics, Two Points, Dichromatic and Differential Spectrophotometry (Dichromatic and Differential Spectrophotometry all belonging to the End Point.)
5. The measurement can be carried out by using standard or factor.
6. It is able to select optionally 8 standard filters: 340nm，405nm，492nm，510nm，535nm，546nm，578nm and 620nm. More over, there is one reserved position available to settle the special filter to meet the requirements of user of different characteristics.
7. The system carries out the detection and control constantly during the period of operation, preventing the creation of error. If there is any abnormal condition, it will send out a signal, and it will display the error information on the screen in the meantime, and guide the user to select the button and operation correctly.

1.2 Instrument Structure

The instrument is composed mainly of the wash system, display, reaction chamber, sample chamber, reagent chamber, aspirate system, rinsing system, diluting system, spectrophotometer and drainage system.

1.2.1 Cleaning System

After opening the back cover, it is found that the left side is equipped with three peristaltic pumps, and a small chamber is found inside for settling the lotion bottle and the waste liquid (Fig. 4). Two peristaltic pumps rotate the aspirateed distilled water and rinse the inside of instrument without intermission, (such as aspirate probe, flow cell, stirrer and diluter injector, etc.) The other pump drains the waste liquid into the waste bottle. The lotion bottle and the waste bottle are located inside the cupboard.



Note: The instrument of new version has already cancelled the waste pump, and the waste liquid is drained toward the waste bottle directly from the waste liquid trough.

1.2.2 Display

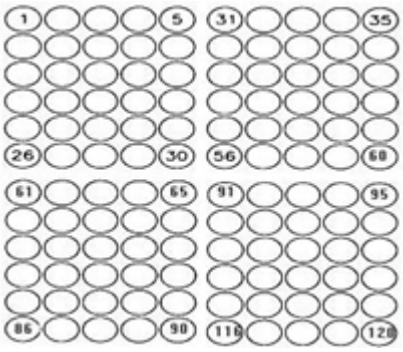
Rayto 200C Plus adopts a color liquid crystal display (LCD) WINDOWS software. The picture is sharp and vivid, and the operator may operate according to the instruction of display.

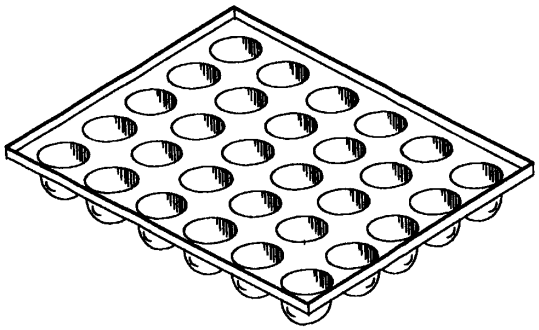
1.2.3 Reaction Chamber

The reaction chamber is constructed from a special alloy material, and is divided into 4 small sections, with each section containing 30 reaction holes, totaling 120 reaction holes altogether (Fig. 5). The reaction can be controlled under three kinds of temperatures: 25℃, 30℃ and 37℃. It is able to replace the reaction tray during the period of work, and after 120 reaction position are exhausted, the display screen will ask the operator to replace the reaction tray. The replacement of reaction tray is carried out in the rinsing process between two reactions, so it will not affect the normal operation.

Disposable reaction tray is made of inert plastics resisting low heat, with each tray containing 30 reaction holes (Fig. 6). While settling the reaction tray, it should ensure that each hole is not broken. The reaction

tray is a type of disposable application.





Reaction chamber Reaction tray

Note: The instrument of the early version had 180 reaction holes, while the instrument of new version contains 120 reaction holes.

1.2.4 Sample Chamber

The sample chamber contains three sample racks, and among them, Rack3 is the STAT sample rack, only for the STAT application. Each sample rack is available for 30 samples (including the standards or quality control). The sample rack is optional for setting small cuvette (12mm × 75mm) or small plastics sample cup (700μl).

1.2.5 Reagent Chamber

The reagent chamber contains two reagent racks, and is available for three kinds of reagent bottles, i.e. small, medium and large bottles. It is available to settle at the left side of reagent rack 18 small reagent bottles (16ml) or 9 large/medium reagent bottles (46ml/32ml). The second reagent rack is available to settle 9 large or medium reagent bottles (32ml) or 18 small reagent bottles (volume 16ml), and available for composite usage of large, medium and small reagent bottles.

The system can configure automatically the position of each working reagent. Each time before operation, the screen will display the required position of each reagent, and will automatically calculate the total volume amount of the required reagent for the operation.

The reagent position in the reagent rack can be set by the system automatically, and also can be set manually.

1.2.6 Aspirate System

Rayto 200C plus adopts the smart X-Y-Z 3D system, driving two probes and a stirrer. The probe with the function of liquid sensor contacts slightly with the liquid and absorbs the volume needed. When it is short of reagent or sample, the instrument will display the prompt information automatically. Probe 1 is the

sample-aspirating probe, which aspirates the reagent and the sample to the reaction hole for hatch. Probe 2 is the liquid-aspirating probe, which absorbs the reaction liquid to the flow cell for measurement. The aspiration period of probe during Rayto 200C Plus operation is as shown in follows:

1. The sample-aspirating probe gets into the reagent bottle and aspirates the amount of reagent as settings and a small section of air.
2. Clean the probe at cleaning pool;
3. The sample-aspirating probe aspirates sample and a small section of air;
4. Clean the probe at cleaning pool again;
5. The sample and reagent are moved into the reaction hole;
6. The mechanical arm returns to the cleaning pool, and the probe and blender are cleaned;
7. The residual sample inside is cleaned by adding a small section of air and 100 μ L distilled water into the flow cell;
8. The liquid-aspirating probe aspirates reaction liquid of 80μL and a small section of air into the flow cell, rinse the flowcell to avoid pollution by different samples;
9. The liquid-aspirating probe aspirates the residual reaction liquid to the flow cell for measurement;
10. The mechanical arm returns to the original position (i.e. cleaning pool) for cleaning the probe, and then the next sample aspiration circulation is carried out.

Generally, the mixing time can be set as 1~2s for measurement by using End Point or Double-reagent.

1.2.7 Rinsing System

For avoiding cross pollution of the system, continuous fresh cleaning fluid is injected into the rinsing pool to rinse the probe, flow cell, stirrer and pipeline.

The diluter will be cleaned by system after sampling, and the volume of cleaning fluid is set by parameters of methodology.

1.2.8 Diluting System

The diluting system of Rayto 200C Plus is controlled by computer, so it is highly accurate and has excellent repeatability. The injector of diluter only contacts the cleaning fluid, so that the reagent can’t enter the injector. After every diluting, the cleaning fluid is injected from injector to rinse the sample probe and pipeline.

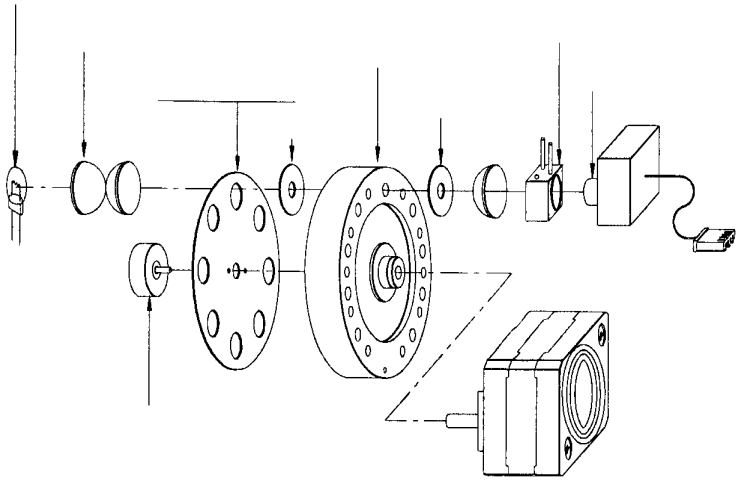
For ensuring the accuracy of result, it is recommended that the volume of a sample should not be less than 5μL, and the total volume for measurement should not be less than 450μL (best in 500μL).

1.2.9 Spectrophotometer

The photometer of Rayto 200C Plus is composed of multiple filters, so that the stability is high. The affect of current thermal drift and external scattered light can be compensated by light source regulator.

The total volume of flow cell is 70μL, and the temperature can be controlled under 25℃, 30℃ and 37℃ (±0.2℃) by Peltier effect. The flowcell should be cleaned and filled with distilled water before every shut-down.

Before test, the analyzer will check automatically if the system is in normal state, rinse the flow cell and adjust each filter to the zero position.



Optical system diagram

1.2.10 Drainage System

There is a drain hole at the middle bottom of the analyzer, which connects to the waste trough inside.

Generally, the waste liquid is discharged into the waste trough first, and then discharged into the waste bottle by peristaltic pump, so that the waste liquid can’t flow out from the drain hole. When the operator executes an illegal operation or a program error occurs which lead to the misoperation of analyzer, the waste liquid inside the waste trough may overflow and flow out from the drain hole at the analyzer bottom.

1.3 Specifications

Weight	100kg
Power supply	AC220V, 50-60Hz
Fuse	250V/3.15A
Analyzing method	End Point, Two Points, Kinetics, and Dichromatic
Throughput	200 item/hour
Filter	8 piece of optical filter (340, 405, 492, 510, 535, 546, 578 and 620nm）
Temperature control	Ambient, 25℃，30℃，37℃
Reagent position	36.
Regent amount	300－500uL recommended
Sample position	90
Sample amount	3-100uL（≥5uL recommended）
Light source	Halogen lamp rating 12V, 20W
Linear range	0-2.500Abs±1%
Sensitivity	Better than 0.0005Abs
Operating environment	15－33℃, 18－85％RH
Measuring method	Factor, single-point standard, multi-point standard

2. Installation & Adjustment

2.1 Unpacking the reader

Unpack and remove materials for transportation. Keep the package box and materials for repackaging.

1) Take out the analyzer from the package.
2) Remove the packing materials and take out the analyzer from the plastic bag.
3) Check the articles in the package box and the following article should be included:

- RT-200C Plus main unit
- User's Manual
- Packing list
- Warranty certificate
- Accessories: Power cable, printer, printer cable, LCD, mouse, keyboard, RS-232 serial cable, and spare fuse.

Note: If any loss of part or difference from the packing list is found, please contact the distributor.

2.2 Installation Environment

Rayto 200C Plus Chemistry Analyzer should be installed by professional. And it should be installed in a clean operating room without dust. Avoid shock, moist, strong magnetic field and direct light. The operating environment should be 15℃ to 33℃, and the relative humidity should be 18-85% (no dewing).

The power supply should be 220V/50Hz and should be securely grounded. If the voltage fluctuation of lab is more than ±10%, an external stabilizer of more than 1,000W is recommended. Since the analyzer is controlled by computer completely, it is equipped with UPS (uninterrupted power supply) of more than 500W.

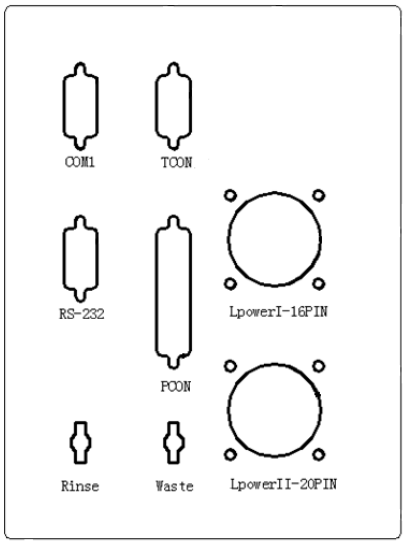
For ensuring the normal operation of the analyzer, please do not install the analyzer at the following places:

- Places where extreme variation in temperature exists
- Extremely hot or cold places.
- Places where large amount of dust exists.
- Places in the vicinity of electromagnetic equipments that generate magnetic field.

Cautions:

- ***The AC power supply should be securely grounded (N-to-G voltage should be <5V).***
- ***The AC power supply should be stable, and should not be used together with a high-power electric apparatus. A UPS stabilized power of 700W is recommended.***
- ***When unplugging the power cable, grasp the plug instead of the cord.***
- ***If smoke, peculiar smell or strange sound is found on the analyzer, you should switch off the analyzer and contact to the maintenance center.***

2.3 Connection of the Analyzer



TCON: Temperature control

RS-232: Standard RS-232 port

COM 1: Serial port

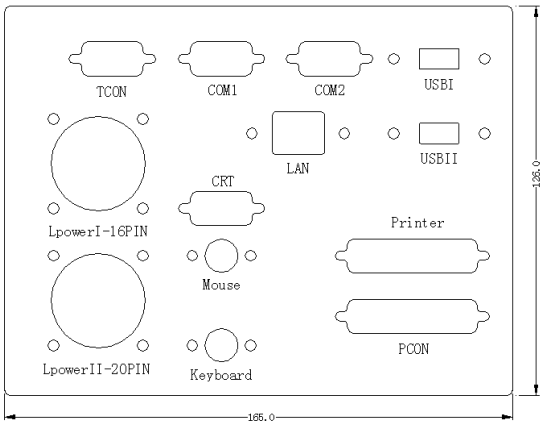
PCON: Power supply control

Rinse : Connection of rinsing pipe

Waste : Connection of waste liquid pipe

LpowerI-16PIN : 16-pin power supply port

LpowerII-20PIN: 20-pin power supply port



USBI、USBII : USB port

TCON: Temperature control

LAN : Network interface

CRT: Monitor interface

COM1、COM2: Serial port

Mouse: Mouse interface

Keyboard: Keyboard interface

Rinse: Connection of rinsing pipe

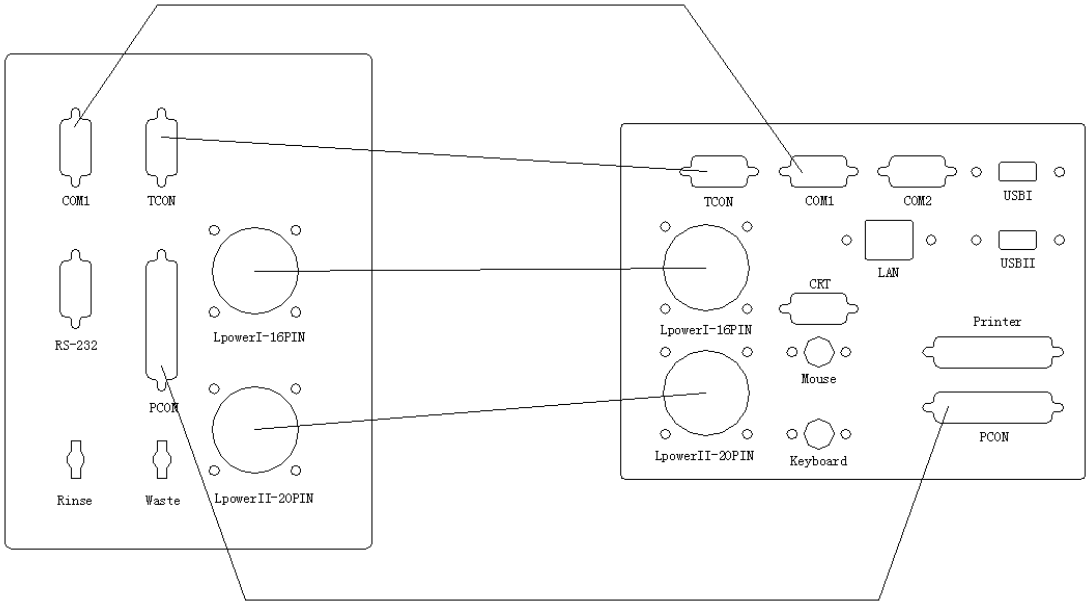
Waste: Connection of waste liquid pipe

Printer: Printer interface

PCON : Power supply control

LpowerI-16PIN : 16-pin power supply port

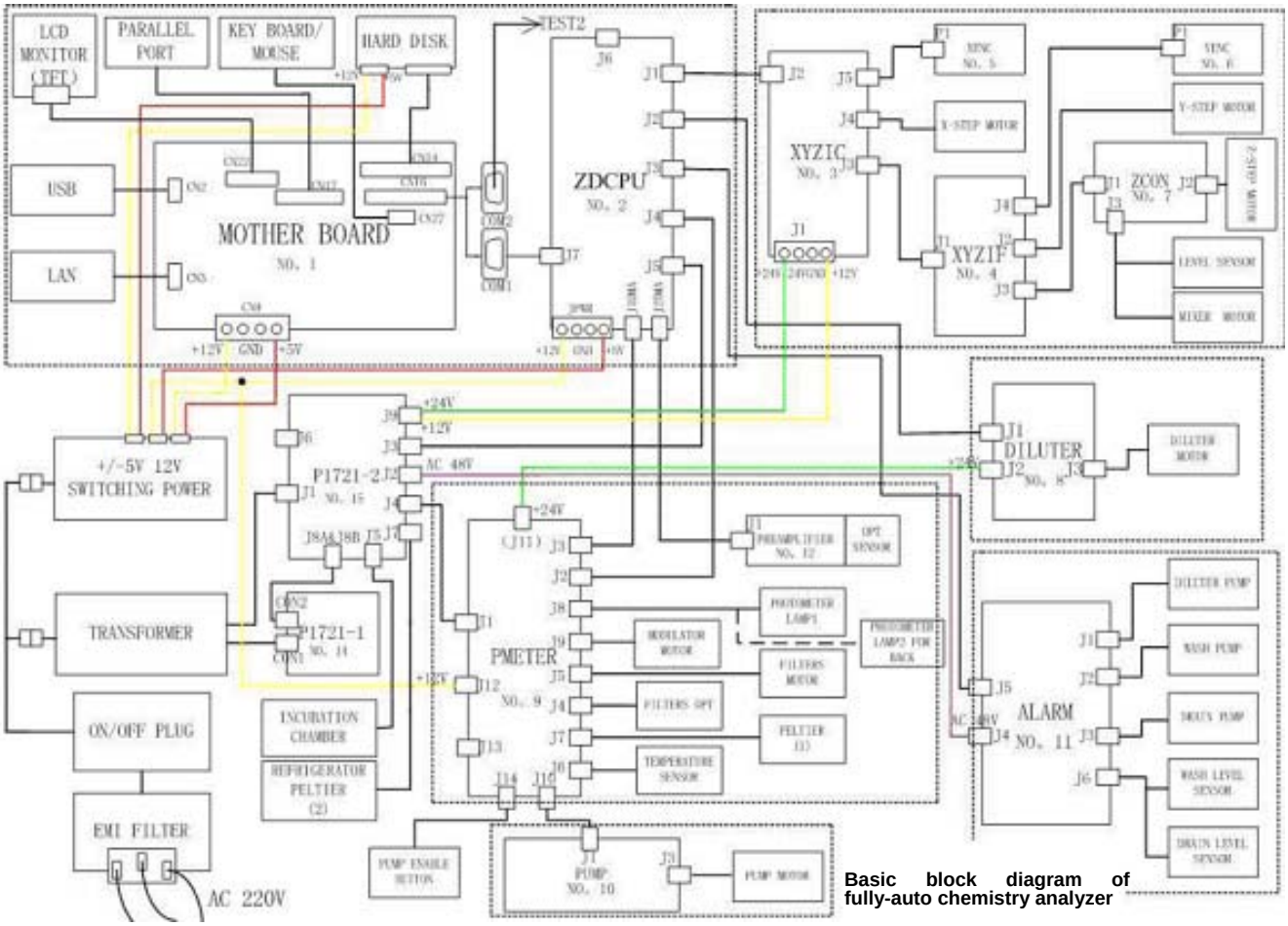
LpowerII-20PIN: 20-pin power supply port



1. Connect the white plastic connector from rack to the white connector on the cover of distilled water bottle; insert its sensor into the Wash interface on the rack.
2. Insert one end of the thick catheter into waste outlet inside the rack, and insert the other end into the waste bottle.
3. Insert one end of the thin catheter into the Rinse interface of the main unit, and insert the other end into the Rinse interface of the rack.
4. Insert one end of the printer data line into the Printer interface at the rear of the rack, insert the other end into the data interface of printer, and connect the power supply of the printer.
5. Insert one end of the display data line into the CRT interface at the rear of the rack, insert the other end into the LCD data line interface, and connect the power supply of LCD.
6. Insert the mouse line into the Mouse interface at the rear of the rack, and insert the keyboard line into the Keyboard interface at the rear of the rack.

3. Functions

3.1 Function Block Diagram of RT-200C Plus



Basic block diagram of fully-auto chemistry analyzer

3.2 Functions of electronic Boards

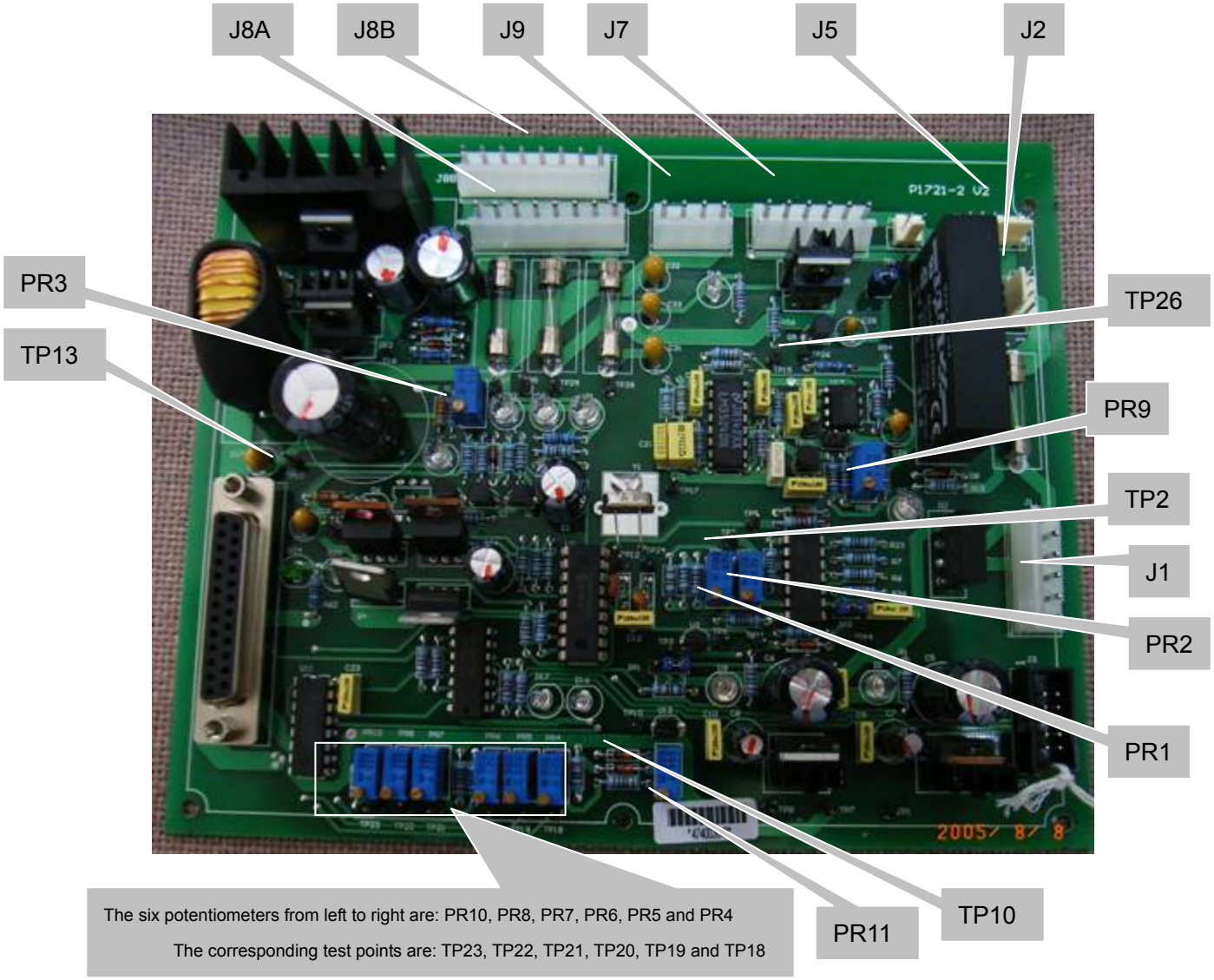
3.2.1 Power Control Board

Power control board is connected to the front CPU board directly, and the temperature selection is controlled by the front CPU board indirectly.

It is mainly for precise temperature control of flowcell and its power driving, tungsten halogen lamp control and its power supply, refrigeration position control and its power supply, incubator and its power supply. Flowcell temperature control module on power control board adopts a set of relatively independent system to the front control system based on front CPU board. It is provided with a 8-bit CPU PIC16C711 and is driven by CMOS power switching diode together with temperature sensor LM335, it becomes a set of typical temperature control system. Tungsten halogen lamp control and its power supply module adopt optical coupler TLP595 as switch, and PWM controller MC34167 as DC-DC converter chip. Refrigeration position and its power supply adopt LM311N as comparator, and 76129P as CMOS power switching diode. Incubator control and its power supply adopt SG3524N as controller

which integrates voltage comparison, power driving and other circuits, and SSR (solid state relay) MP240D4 as switch.

Figure of a real power control board (Board No.: 15)



Voltage of each connector:

J8A: Power input interface, connect to DC +5V and +12V outputted from PC power supply.

From left to right: /, /, /, /, DC+12V, GND, DC+5V and GND.

J8B: Power input interface, connect to the DC+5V and DC+12V outputted from PC power supply, and to DC+24V outputted from power board.

From left to right: DC+24V, DC+24V, GND, GND, DC+12V, GND, DC+5V and GND.

J9: Voltage output interface, outputs DC+24V for X- and Y-axis motors, injector motor.

Input DC+12V for Z-axis motor.

From left to right: DC+24V, GND, GND and DC+12V.

J7: Refrigeration position control. Pins 1-2 at the left output DC +12V for refrigerating chamber, Pins 3-4 output DC +12V for Peltier in refrigerating chamber, Pins 5-6 are connected to temperature sensor of refrigerating chamber.

J5: Incubator control. Pins 1-2-3 are connected to temperature sensor, Pin 4 is idle, Pins 5-6 output AC 48V for heating wire of incubator.

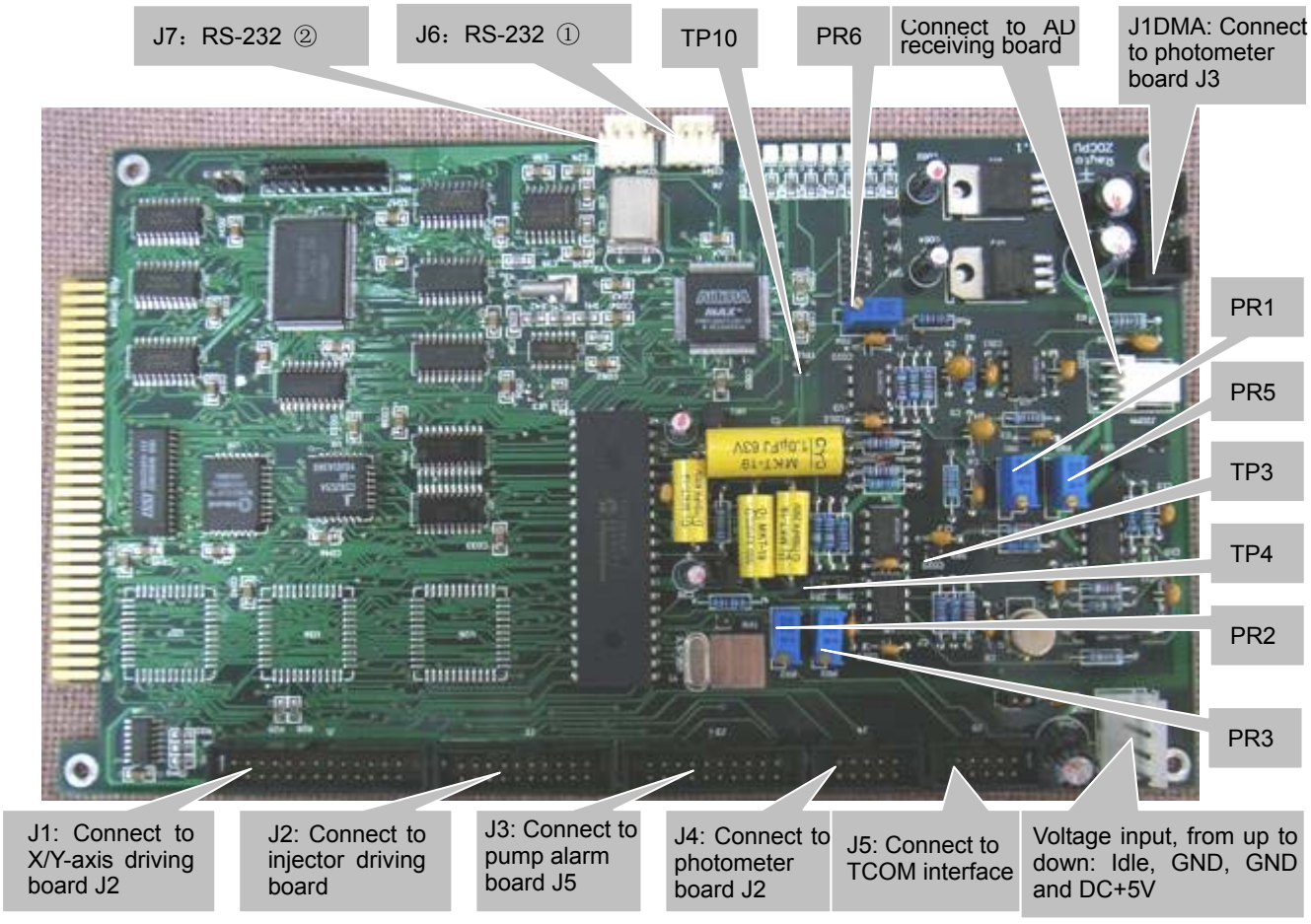
J2: Outputs AC48V for rinsing pump and injector pump.

J1: Power input interface, is connected to AC48V and AC18V outputted from transformer. Pins 1-2-3 from up to down are two groups of AC 18V, Pin 4 is idle, Pins 5-6 are one group of AC 48V.

3.2.2 Front CPU Board

The front CPU board is the control center of the whole analyzer, it is connected to rear control board through J6 to implement the rear control command; the smallest sub-system is consisted of H8S/2350, memory chip U29 and U30 of front CPU; control signal is implemented by IO interface of H8S/2350 and outputted to each control board after driving; the logic control of the board is implemented by the on-board EPLD element; clock signal of X-, Y-axis and injector motors is generated by chip 8254; the board also implements data collection for analog signal, which is inputted through interface J2DMA, and be used for A/D conversion by ICL7109 and collection by H8S/2350 after signal amplification and log conversion.

Diagram of a real front CPU board (board No.: 02)

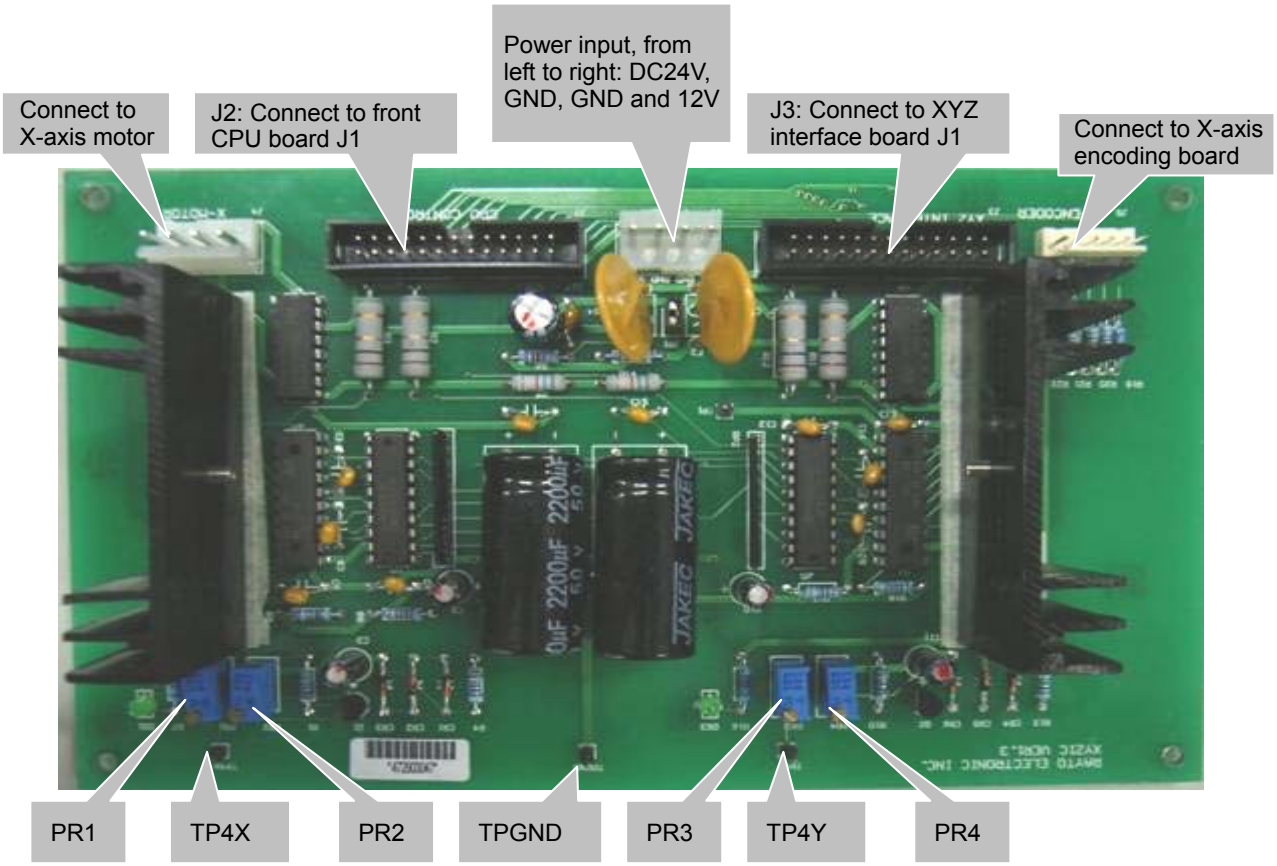


3.2.3 XY Driving Board

One end of the injector driving board is connected to front CPU board, the other end is connected to XYZ switching board. It is controlled by front CPU board and its motor clock signal is offered by 82C54 with Timer/counts IC which controls the speed and rotation position of the motor. Motor direction signal, motor Enable signal and switching signal to low consumption of motor are offered by front CPU board.

The main functions it implements are to control the X- and Y-axis motor, drive the power and switch between low consumption and operating mode. The logic control of XY driving board adopts a piece of L297, driving chip adopts a piece of L298 of which operating voltage is +24V, and its driving current is set by the reference voltage of L297. Y-axis motor is connected by XYZ switching board. In addition, the board only offer switching for the control signal of Z-axis motor.

Diagram of a real XY driving board (board No.: 03)

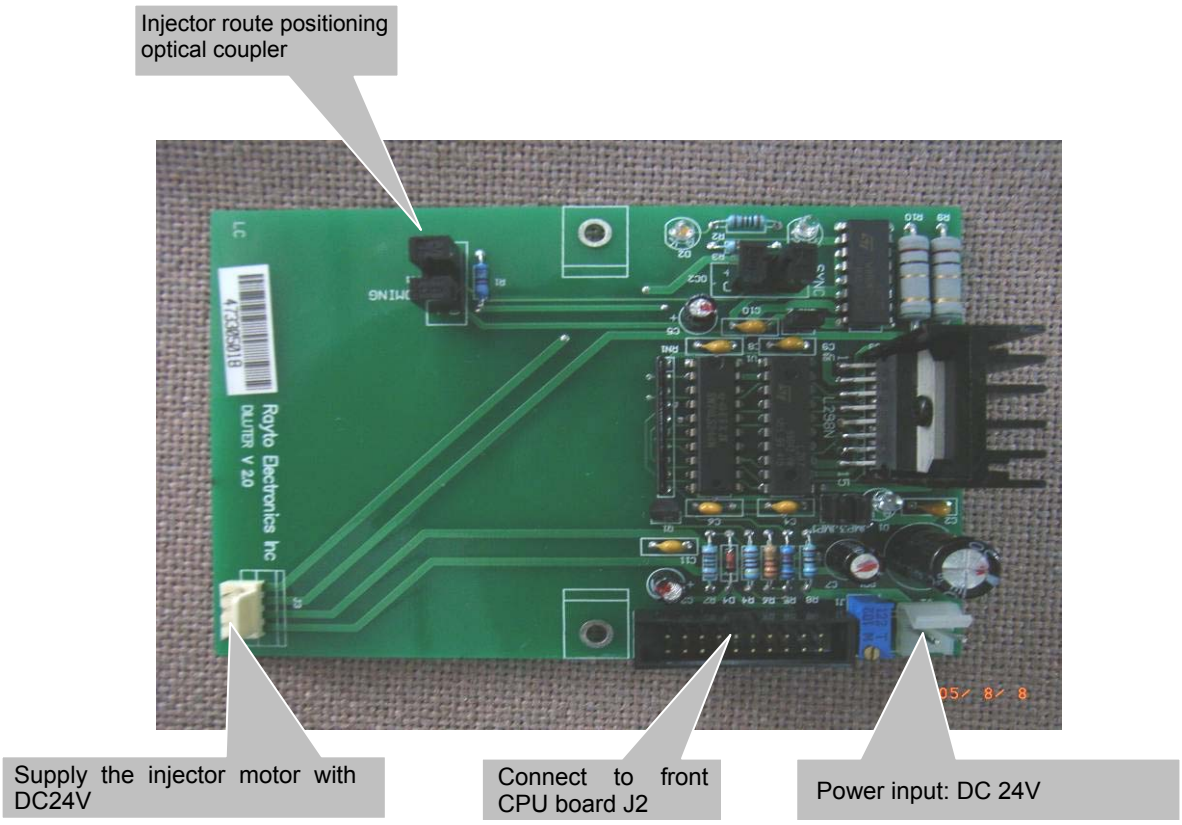


3.2.4 Injector Driving Board

The injector driving board is connected to front CPU board directly and is controlled by front CPU board. its motor clock signal is offered by 82C54 with Timer/counts IC which controls the speed and rotation position of the motor. Motor direction signal, motor Enable signal, motor low consumption switching signal, motor reset signal, etc. are connected to MCU interface of front CPU board.

The main functions it implements are to control the injector motor, drive the power and switch between low consumption and operating mode. The logic control of injector driving board adopts a piece of L297, the driving chip adopts a piece of L298 of which operating voltage is +24V, driving current reaches 4A. In addition, for protecting the motor during motor driving, a discharge diode is added to the circuit and the protection is implemented by L6210.

Diagram of a real injector driving board (board No.: 08)

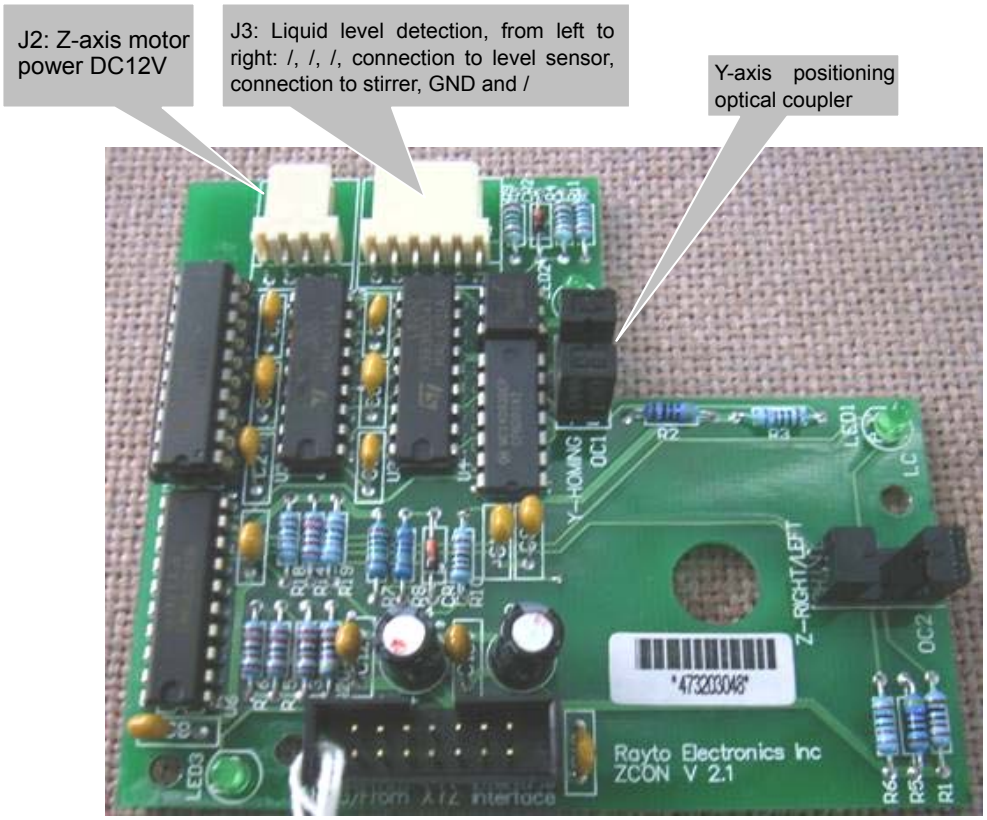


3.2.5 Z-axis Control Board

The Z-axis control board is connected to front CPU board through XYZ switching board and XY driving board, and is controlled by front CPU board. The motor clock signal is controlled by timer TPU integrated in MCU of front CPU board which controls the speed and rotation position. Motor direction signal, motor Enable signal and motor reset signal are offered by interface on MCU of front CPU board.

It is mainly for controlling and power driving the Z-axis motor of XYZ 3D mechanical arm. Logic control of Z-axis control board adopts a piece of programmable logic component GAL16V8B, the driving chip adopts two pieces of L6202 of which operating voltage is +12V and driving current reaches 1.5A. The driving chip is integrated with CMOS power switch diode and motor braking protection circuit.

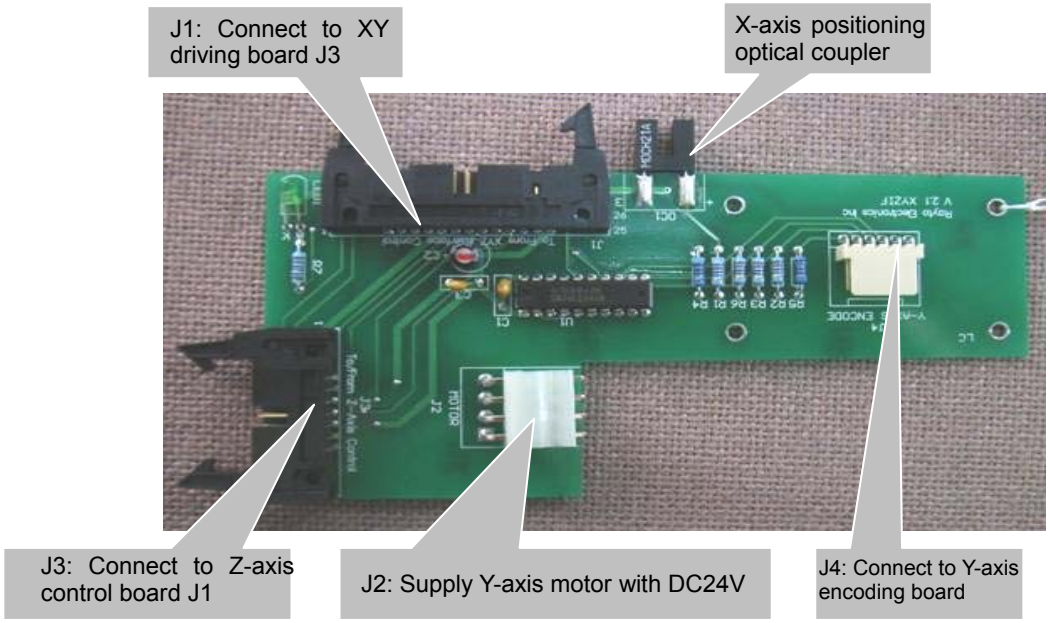
Diagram of a real Z-axis control board (board No.: 07)



3.2.6 XYZ Switching Board

It is mainly for controlling Z-axis motor signal for long wiring driving and detecting X-axis motor reset signal. The signal driving of Z-axis control board is implemented by 74LS244, and reset signal of X-axis motor is implemented by optical coupler.

Diagram of a real XYZ switching board (board No.: 04)

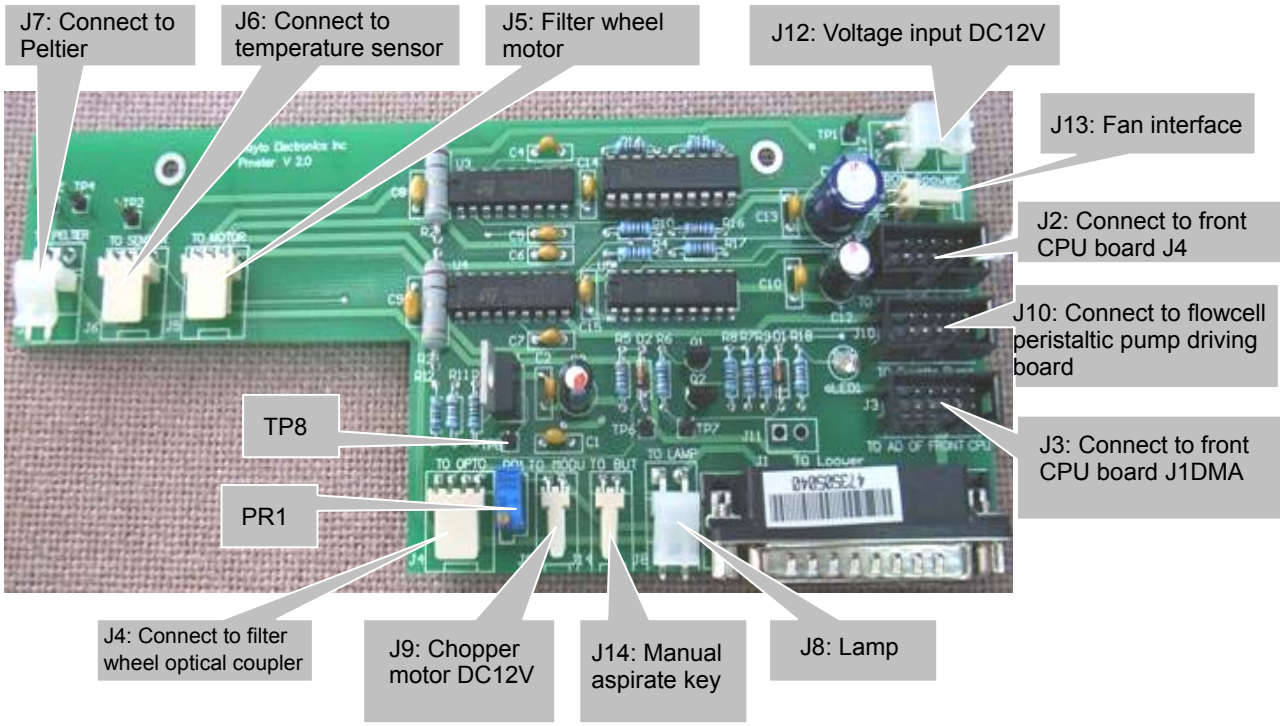


3.2.7 Photometer Board

The photometer board is connected to front CPU board directly and controlled by front CPU board. Its motor signal is controlled by the timer TPU integrated in MCU of front CPU board which controls the speed and rotation position. Motor direction signal, motor Enable signal and motor reset signal are offered by interface on MCU of front CPU board. In addition, it is connected to power control board through external 25PIN cable. The power control board is for precise control of flowcell temperature, offers signal interface and power interface.

It is mainly for control and power driving of filter wheel motor in light-path system, and offers temperature control interface of flowcell. Its logic control adopts a piece of programmable logic component GAL16V8B, driving chip adopts two pieces of L6202 of which operating voltage is +12V and driving current reaches 1.5A. The driving chip is integrated with CMOS power switch diode and motor braking protection circuit.

Diagram of a real photometer board (board No.: 09)

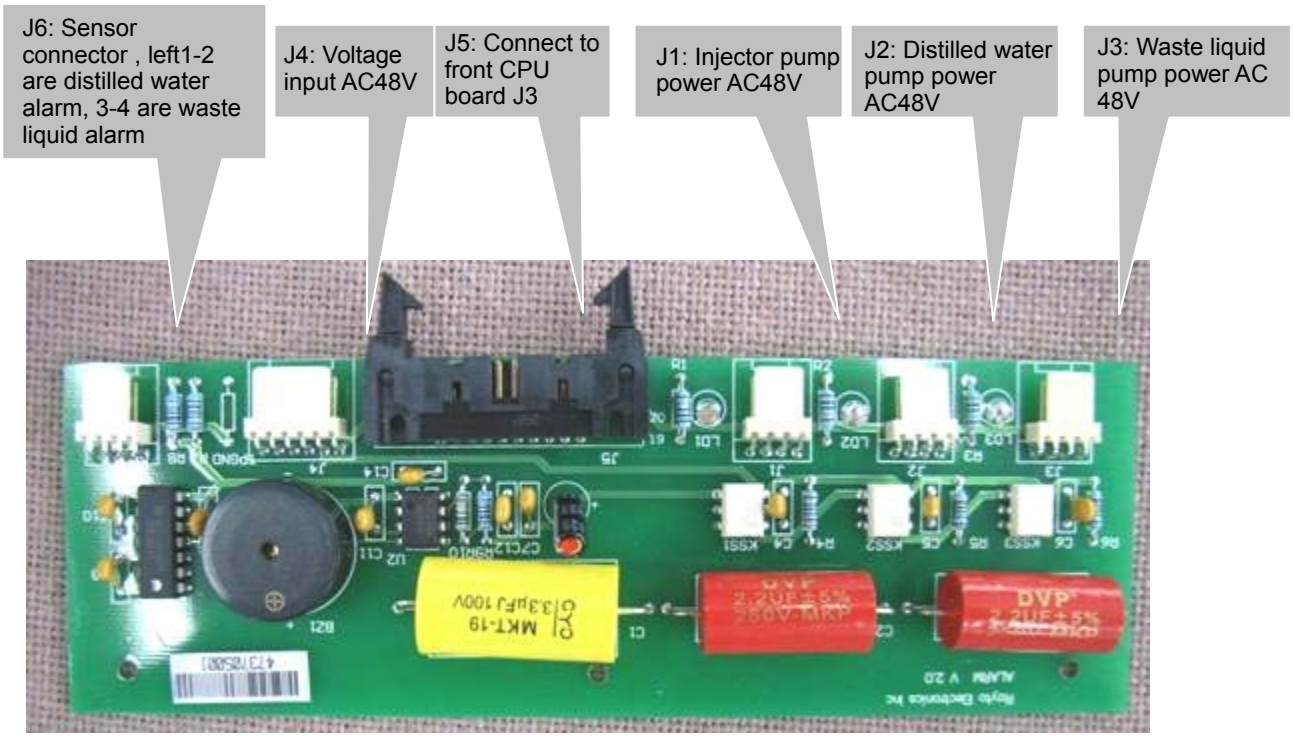


3.2.8 Alarm Board

The alarm board is connected to front CPU board directly and controlled by the front CPU board. The switch signal of AC motor is connected to MCU interface of front CPU board.

It is mainly for switch control and power driving of three pumps motors, and hardware alarm. The switch control of alarm board adopts three pieces of optical coupler switches K3022P for switching among waste pump, pump for cleaning sample probe and pump for cleaning trough. In addition, hardware alarm is implemented by a piece of NE555 which has timing function for detecting the level of waste liquid and cleaning fluid. And this function isn‘t interrupted by software.

Diagram of a real alarm board (board No.: 11)



3.2.9 Flowcell Peristaltic Pump Driving Board

The flowcell peristaltic pump driving board is connected to the front CPU board through photometer board, and is connected to the front CPU board. Its motor clock signal isn't controlled by front CPU board for controlling speed and rotation position. The clock signal is supplied after shaping of RC circuit on flowcell peristaltic pump driving board. But motor Enable signal, motor fast/slow switching signal, etc. are connected to the MCU interface of front CPU board.

It is mainly for peristaltic pump motor control of flowcell peristaltic pump driving board, and drives the power. It is provided with manual and automatic modes. Its logic control of flowcell peristaltic pump adopts a piece of programmable logic component GAL16V8B, driving chip adopts two pieces of L6202 of which operating voltage is +12V and driving current reaches 1.5A. The driving chip is integrated with CMOS power switch diode and motor braking protection circuit.

3.2.10 Signal Receiving Board

The signal receiving board is connected to AD part of front CPU board directly through a coaxial cable of which characteristic impedance is 50ohm. It sends photoelectricity signal to AD module on front CPU board for processing.

It is mainly for sampling luminous intensity. Its function is implemented by photoelectric cell KHS14, and the signal is converted into voltage analog signal by I/V conversion chip LF356N.

Diagram of a real signal receiving board (board No.: 12)

(From left to right: DC-15V, GND, signal receiving, and DC+15V)

3.2.11 X-axis Encoding Board

X-axis encoding board is connected to front CPU board through XY driving board, and feedbacks signal to the front CPU board.

3.2.12 Y-axis Encoding Board

Y-axis encoding board is connected to front CPU board through XYZ switching board and XY driving board, and feedbacks signal to front CPU board.

3.2.13 Liquid Level Detecting Board

The liquid level detecting board is connected to front CPU board through Z-axis control board, XYZ switching board and XY driving board, and feedbacks signal to front CPU board. It detects whether the sample probe reaches the level of the measured liquid by contacting the mechanical contact.

4. Replacement of Accessories

4.1 Disassembling

RT-200C Plus is a complicated high-precision analyzer. In case a failure that can't be solved according to the method above, the analyzer should be repaired by professional personnel who can find out the problem and part should be repaired or replaced. Please disassemble the analyzer according to the following procedures:

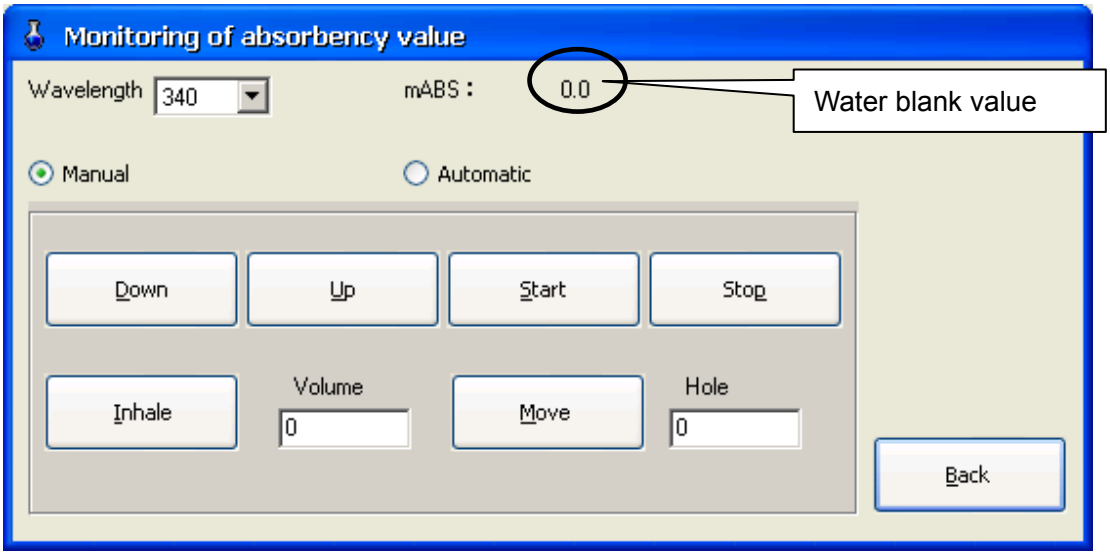
1) Switch off the power switch.

2) Remove four screws of the rear baffle with screwdriver.

3) Lift the rear cover of the analyzer. Now we can see the internal structure of the analyzer clearly for repair.

4.2 Replacement of Lamp

1. Shut down the system and lift the rear cover of the analyzer.
2. Pull out pin P1 of lamp from PCB.
3. Remove the positioning button ③.
4. Loosen the fixing button ⑤ and remove the lamp carefully.
5. Insert a new lamp and screw the positioning button ③ (but not fix the button). Pay attention to your hand to avoid touching the bulb (the bulb can be wrapped up by plastic film). Insert pin P1 of the lamp into socket J8 on PCB.
6. Start up the analyzer and enter the “System Monitoring” program.
7. Select wavelength 340nm, measured mean value of water blank will be displayed on the screen continuously, as shown in figure below:



8. Press MANUAL PUMP key for aspirating distilled water to the flow cell.
9. Adjust the positioning button ③ for adjusting the lamp vertically, and observe the value on screen simultaneously, and then adjust the positioning button ④ for adjusting the lamp transversely until the absorbency value reaches the minimum value (it should be less than 300mAbs).
10. Tighten the fixing button ⑤ and close the rear cover.
11. Shut down the system.

Caution: Do NOT expose your eye to direct ultraviolet ray of 340nm to avoid eye injury during adjusting the lamp position.

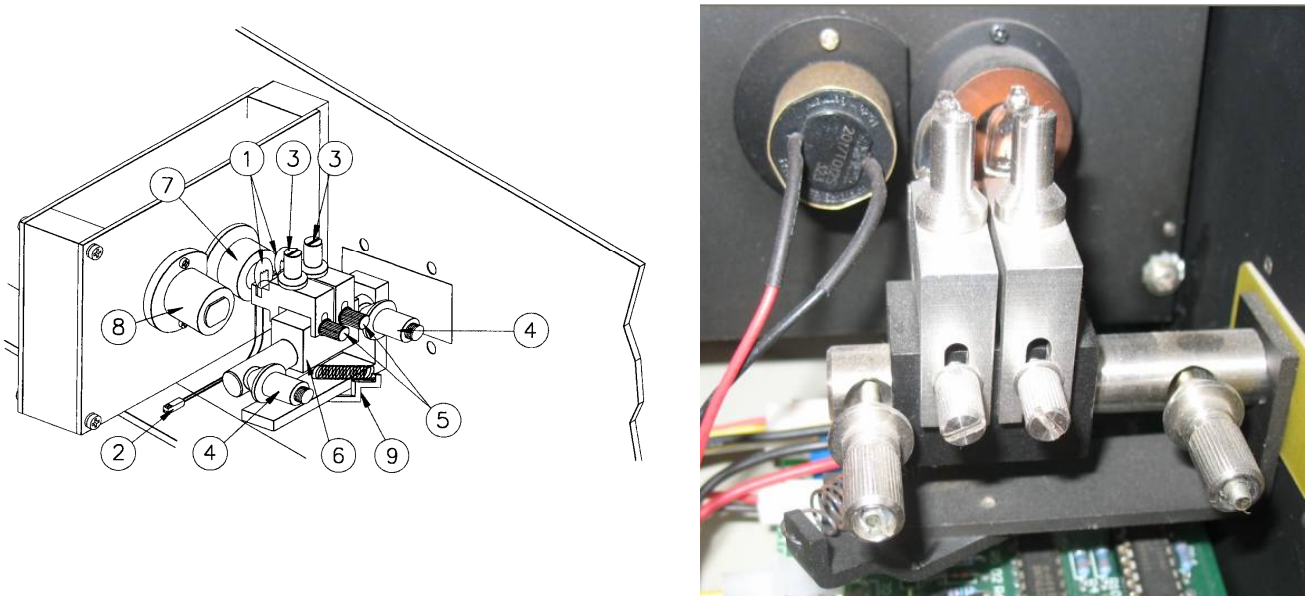


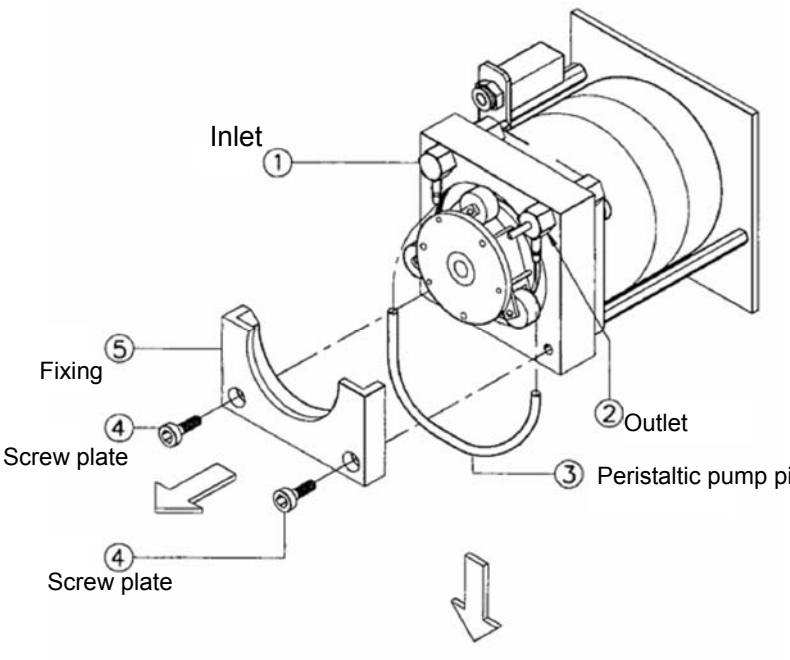
Fig. 65 Lamp

①Lamp ②Pin of lamp ③Vertical positioning button ④Level adjuster ⑤Fixing button
⑥Lamp holder ⑦Lens ⑧Motor ⑨Level converter of lamp

4.3 Replacement of Peristaltic Pump tube

1. Lift the rear cover; you can see the peristaltic pump on the right, as shown in below figure.
2. Remove two hexagon socket head cap screws ④
3. Remove the fixing board ⑤
4. Remove the pump tube ③ and replace it with a new pump tube of the same size.
5. Reassemble and start up the system to check whether it is normal.

Note! : There is two peristaltic pumps at the left rear of the analyzer, the replacement method of pump tube is the same as the method above.



Structure diagram of peristaltic pump

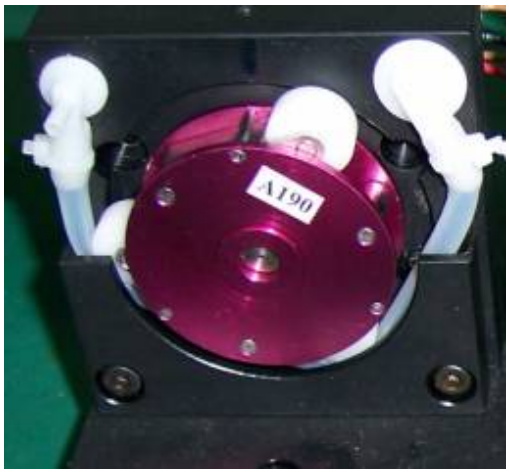


Diagram of a real peristaltic pump

4.4 Replacement of Injector

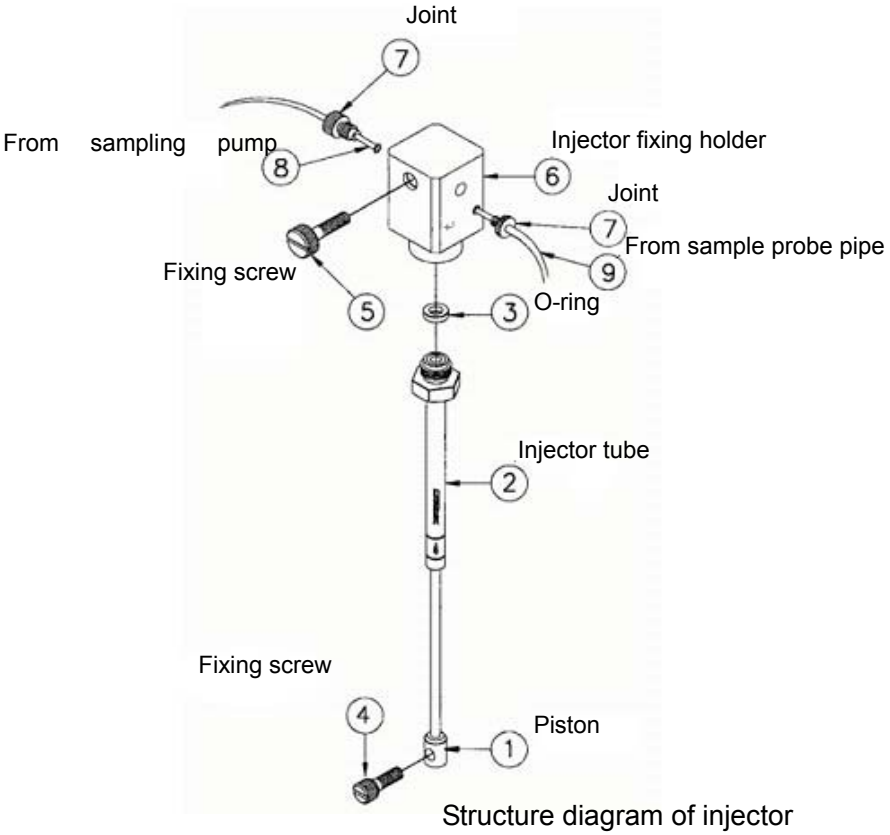
1. Loosen the screw ④ and remove the injector ② and piston ①.
2. Replace them with a new injector and piston and check if the gasket is installed.

Caution: Do NOT dissemble the diluter for normal problem (except a leakage or breaking of diluter occurs).

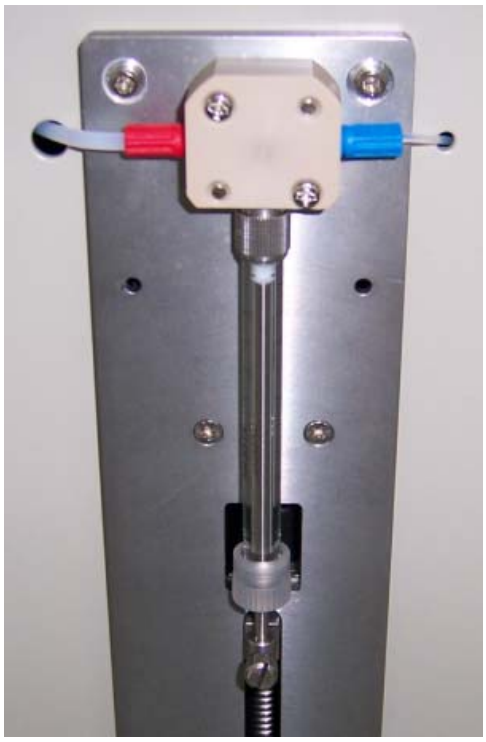
The following three points should be aware during replacement of injector:

1, Replace with a new injector, and install O-ring 3 securely for good leakproofness.

2, The new injector should be installed strictly according to “3-point, 1-line”, i.e. the fixing screw 5 at the center of injector installation block should be at the same line of original position 2 and rinsing position 1 of injector piston. It is very important.



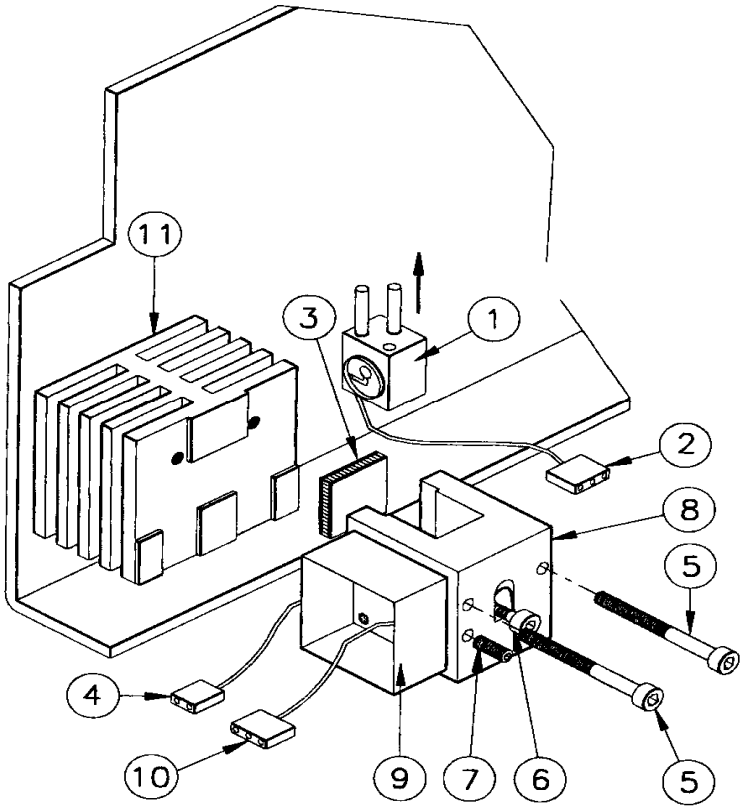
Structure diagram of injector



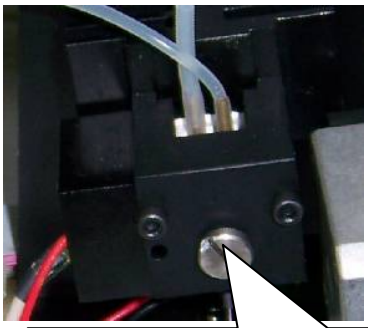
Picture of a real injector

4.5 Replacement of Flowcell

1. Shut down system and lift the rear cover of the analyzer.
2. Remove the sample inlet and outlet tubes of flowcell, and remove the temperature sensor connector ④ from the flowcell.
3. Raise spring regulator ⑥ with flat-blade screw driver outwards slightly, shake the flowcell forwards and backwards, and then pull out the flowcell (remember the installation direction of the flowcell).
4. Loosen the screw for flowcell temperature sensor, and remove the temperature sensor.
5. Apply some thermal grease on the hole which is close to the Peltier direction of the flowcell, install the temperature sensor in the hole, fix the screw and check if the sensor line is loose or short-circuit.
6. Raise spring regulator ⑥ with flat-blade screw driver outwards slightly, and insert the new flowcell into the installation hole. You should press the flowcell until the bottom of hole, and the height of flowcell should be just equal to the height of Peltier.
7. Insert the temperature sensor connector into J6, insert the sample-inlet tube into sample-inlet joint, and insert the sample-outlet tube into sample-outlet joint.
8. Start up the analyzer and enter the monitoring program to monitor the water blank value. At this time, you can insert a screwdriver into the hole on the flowcell and raise the flowcell forwards and backwards slightly to observe the water blank value. You can stop when the water blank value is the minimum value, because the position is correct.
9. Fix the rear cover of the analyzer securely.



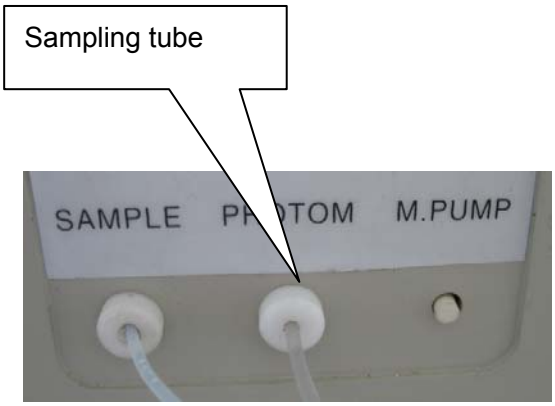
①Flow cell
②Plug (to J6)
③Peltier
④Plug (to J6)
⑤Screw ⑥Spring regulator
⑦Fixing lock⑧Fixing block
⑨Pre-amplifier
⑩Plug (to J2)
Radiator



Spring regulator: Raise the cell outwards to remove it easily

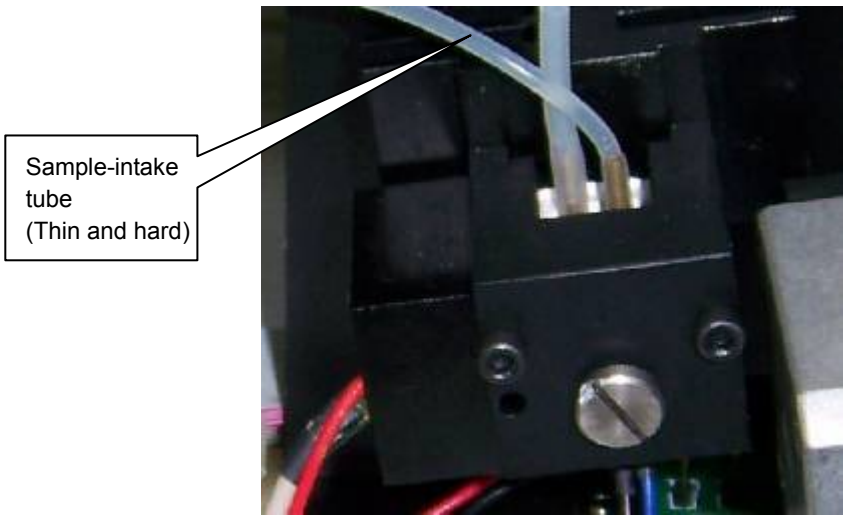
4.6 Replacement of Sampling Tube (Connect the sampling probe to flowcell)

1. Switch off the analyzer; remove the plastic cover on sampling head according to the figure below. You can see two plastic tubes, the pin close to the inside is for connecting Sampling tube, pull out the Sampling tube from sampling probe.



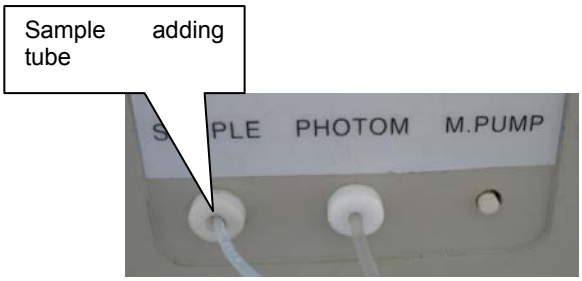
2. Lift the rear cover of the analyzer, you can see the flowcell (as shown in figure below), the thin tube is sampling tube. Pull out the Sampling tube from the flowcell and replace it with a new one, and then installed it securely in the same way. (**Note: Since the bore of sampling tube is very small, the**

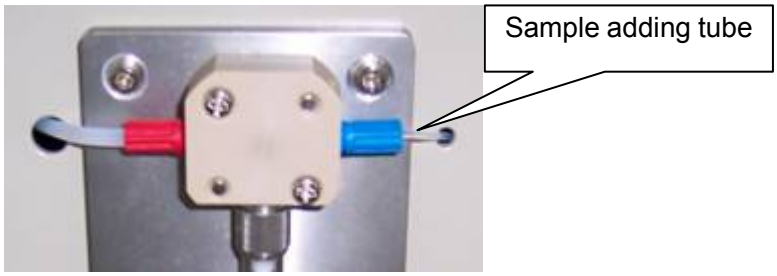
tube may not easily be installed into the flowcell easily, a sharp substance is necessary to enlarge a section of tube mouth for setting the tube into the flowcell. This section should not be used with switching tube, because that may affect the result.)



4.7 Replacement of Sample adding Tube (Connect the sample probe to the injector)

1. Switch off the analyzer; remove the plastic cover on sampling head according to the figure below. You can see two plastic tubes, the pin close to the outside is for connecting sample adding tube, pull out the sample adding tube from sample adding probe.

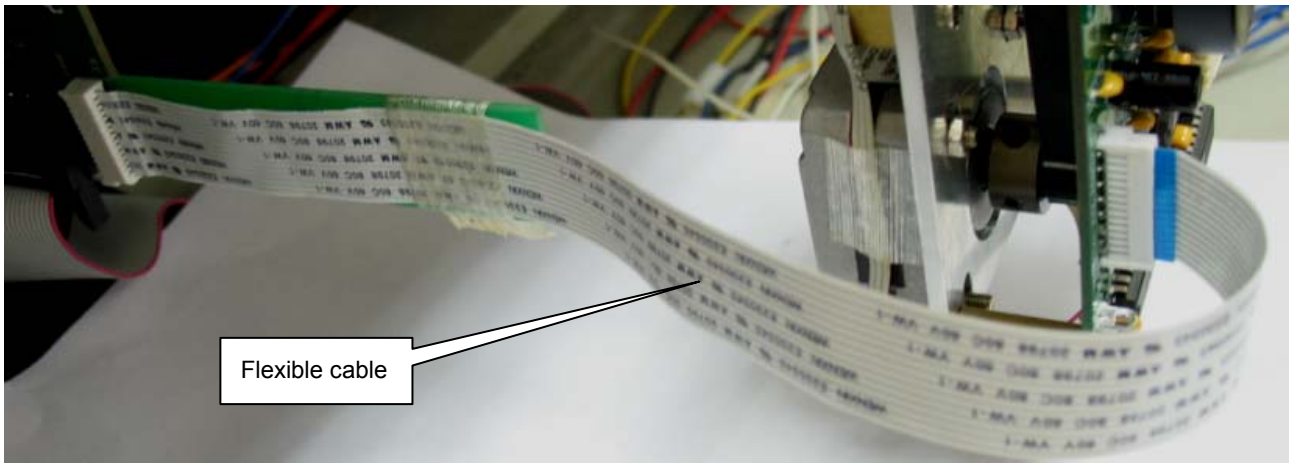




2. Remove the joint at the right of injector three-way as shown in figure above.
3. Lift the rear cover of the analyzer and remove the joint, replace the joint with a new one of the same type, and fix it securely in the same way. Please ensure securely fix the tube to ensuring the leakproofness.

4.8 Replacement of Flexible Cable (for analyzer of new version)

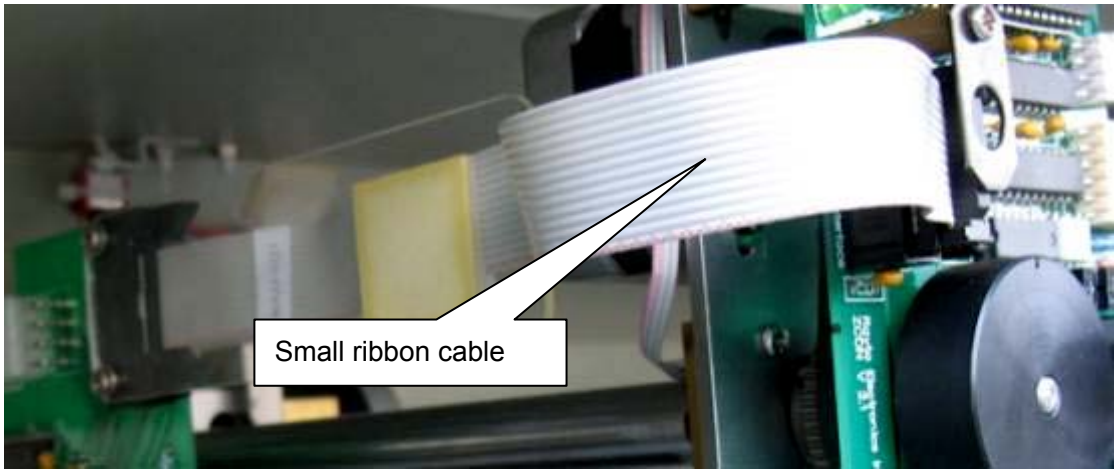
1. Switch off the analyzer, lift the rear cover of the analyzer, you can see the flexible cable as shown in figure below.



2. Remove the flexible carefully, replace it with a new one and fix it in the same way.

4.9 Replacement of Small Ribbon Cable (for analyzer of old version)

1. Switch off the analyzer, lift the rear cover of the analyzer, you can see the small ribbon cable as shown in figure below.

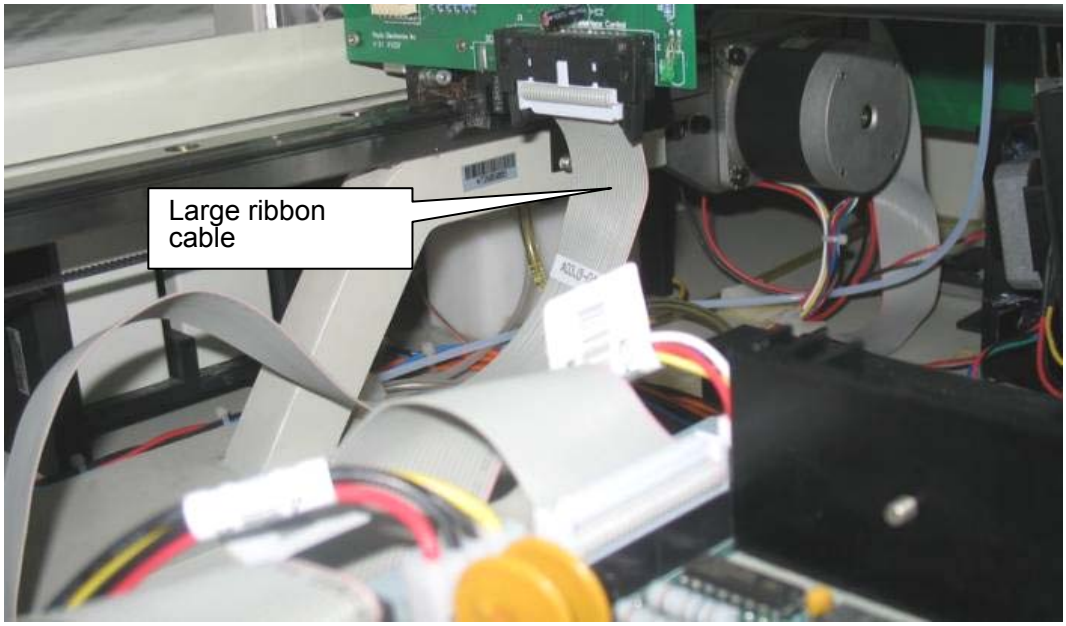


2. Remove the small ribbon cable carefully, replace it with a new one, and fix it securely in the same way.

Note: The analyzer of old version adopts small ribbon cable, and the analyzer of new version adopts flexible cable.

4.10 Replacement of Large Ribbon Cable

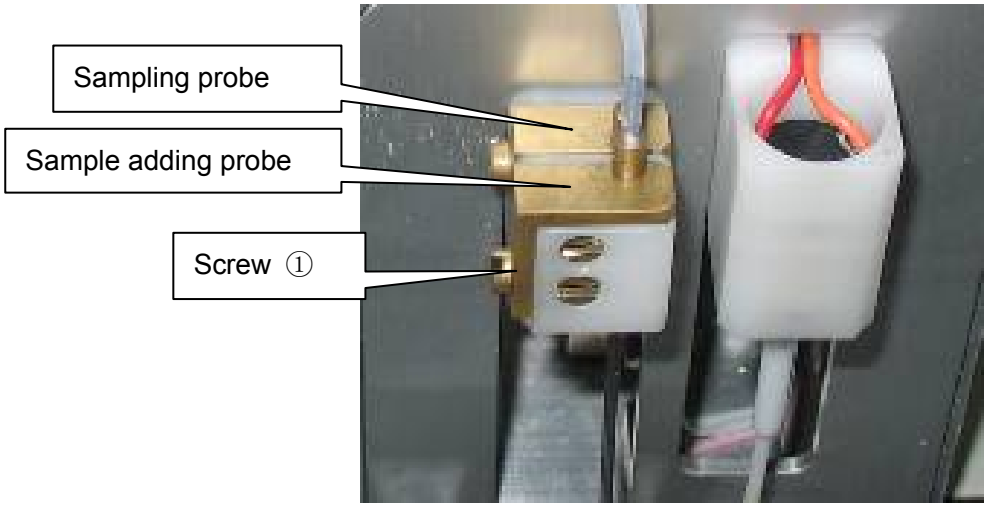
1. Switch off the analyzer, lift the rear cover of the analyzer, you can see the large ribbon cable as shown in figure below.



2. Remove the large ribbon cable carefully, replace it with a new one, and fix it securely in the same way. Pull the cable to the Sampling head by hand, move it along the X-axis direction back and forth, and observe the movement of the large ribbon cable. The movement of the large ribbon cable should be free and should not be blocked by the other cables.

4.11 Replacement of Sample adding Probe/Sampling Probe (for analyzer of old version)

1. Switch off the analyzer, lift the plastic cover on Sampling head, you can see two metal probes, the outer one is sample adding probe, the inner one is sampling probe.

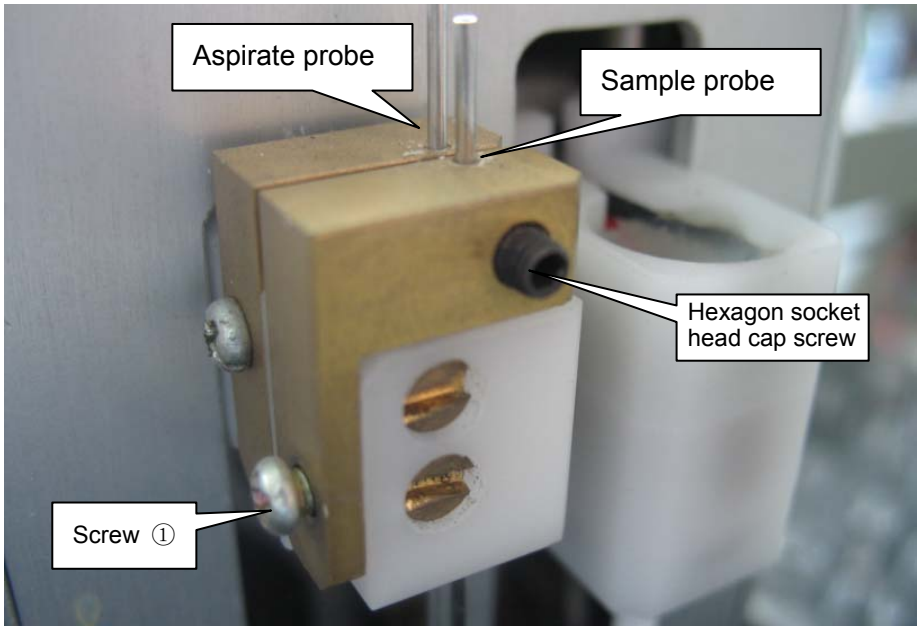


2. Pull out the Sample adding tube on the sample adding probe, remove screw ① on sample adding probe to remove the probe.
3. Replace the sample adding probe with a new one, fix it in the same way and fix the screw.
4. Close the cover for the probe.

Note: The same to the method to replace the sampling probe.

4.12 Replacement of Sample Probe/Aspirate Probe (for analyzer of new version)

1. Switch off the analyzer, remove the plastic cover on Sampling head, you can see two metal probes, the outer one is sample probe, the inner one is aspirate probe.



2. Pull out the Sampling tube on sample probe, loosen the hexagon socket head cap screw on sample probe as shown in figure above, remove the sample probe.
3. Replace it with a new one, fix it in the same way and fix the hexagon socket head cap screw.
4. Close the cover for the probe.

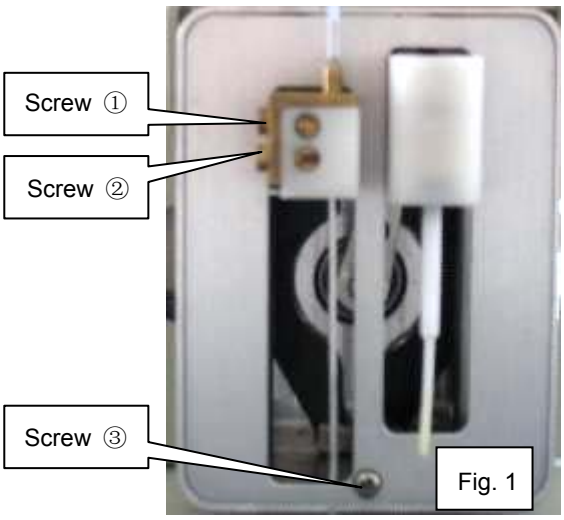
Note: You should connect the sampling probe to the installation holder first, and install it on Sampling head for replacement of sampling probe. As shown in the upper right figure.

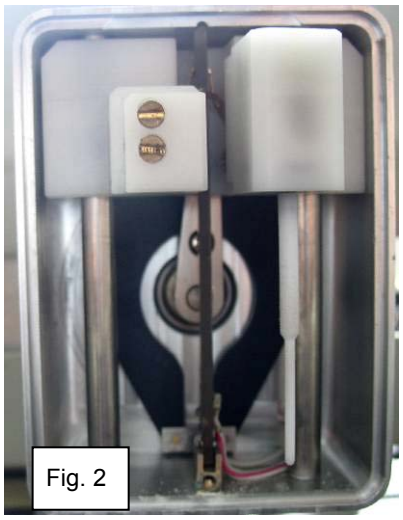
Note: The sample probe structure of analyzer of old version is different from that of the new version.

4.13 Replacement of Z-axis Contact Spring

1. Switch off the analyzer, lift the rear cover of the analyzer, and remove the plastic cover on sampling head.

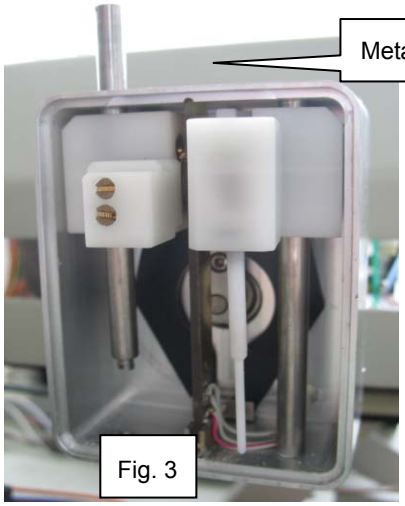
2. Remove screws ① and ② in the Fig. 1 below, and remove two metal probes.

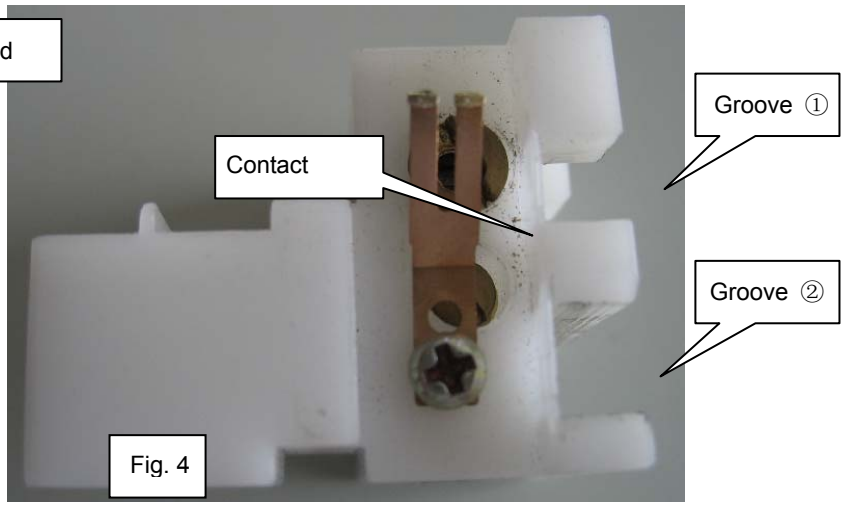




3. Remove screw ③ in Fig. 1 below, remove the metal cover, you can see the structure as shown in Fig. 2.

4. Remove the metal rod as shown in Fig. 3, and remove the installation block for Sampling head as shown in Fig. 4.





5. Remove the contact spring, replace it with a new one, fix the new contact spring in the same way.

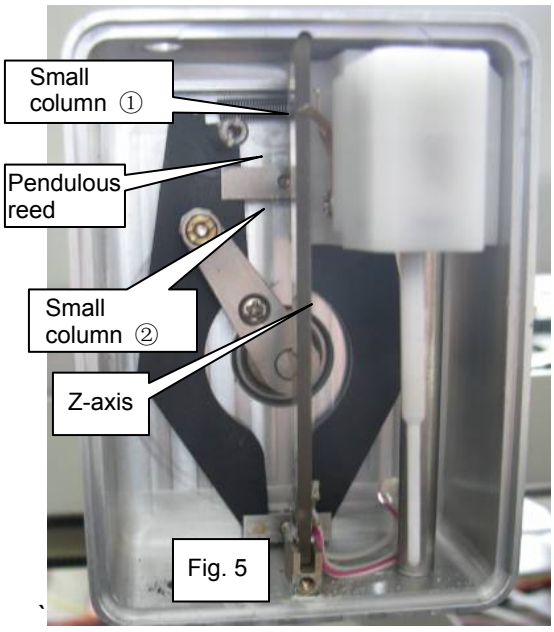


Fig. 5

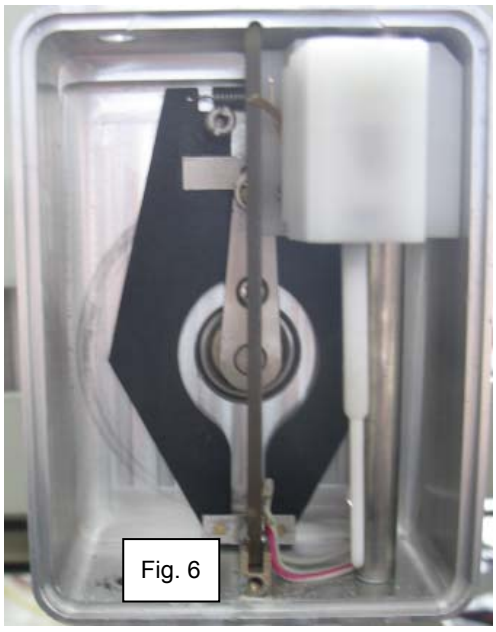


Fig. 6

6, Remove the Sampling head of installation block of sampling head as shown in Fig. 5. During installation of installation block of sampling head, adjust the Z-axis to the position that is perpendicular to the plane first as shown in Fig. 6, and then install the installation block carefully. The column ① on Z-axis should be set in groove ① of the installation block, and the column ② on pendulous reed should be set in groove ② of the installation block. Install the metal pole.

7. Turn the black disc on Z-axis control panel at the rear of the analyzer (Z-axis encoding disc) by hand, and check if the sample probe and stirring rod move freely. If they move freely, the next procedure can be carried out; if not, you should reinstall them.

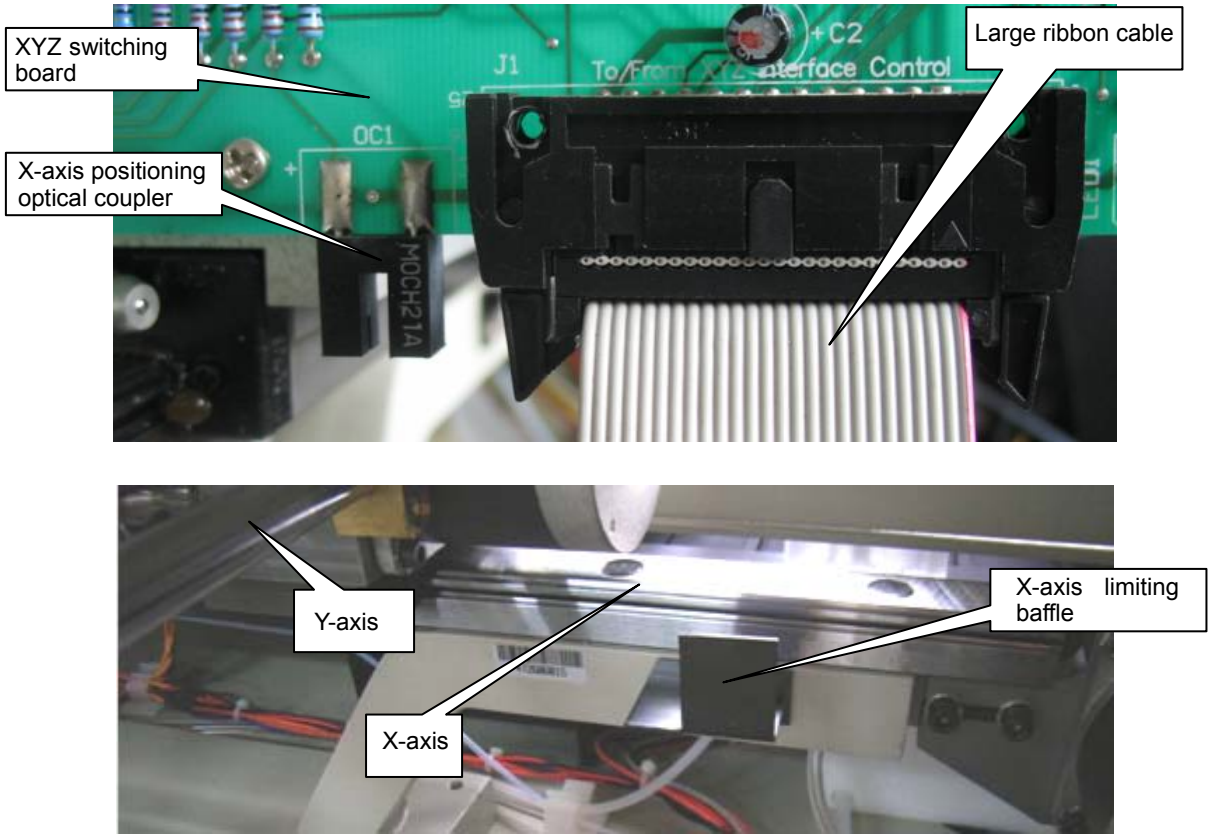
8. Install the metal panel for the sample probe.

9. Install the two metal probes, and close the plastic cover for Sampling head.

Note: It is the same as the method to replace the contact spring of stirring rod.

4.14 Regulation of X-axis Zero Point

The positioning of X-axis zero point can be carried out by limiting baffle on X-axis together with X-axis positioning optical coupler on XYZ switching board. When it moves to the limiting baffle and block the detecting optical coupler, XY driving board detects the voltage change feedbacked by optical coupler and determines the zero point is reached, and stops moving. Regulation of X-axis positioning is mainly for limiting the position of the baffle.



The regulation method is as follows:

1. Switch off the analyzer, and lift the rear cover of the analyzer.
2. Move the Sampling head to the original position (the sample probe just faces towards the waste liquid hole). At this time, observe the positions of X-axis positioning optical coupler and limiting baffle, the limiting baffle should just block the middle of the optical coupler. If not, you can adjust the position of limiting baffle.
3. After the adjustment, start up the analyzer to check the X-axis position during start-up self-test. If an offset exists, you should go on adjusting. If the probe feed position is accurate, the regulation is complete, close the rear cover of the analyzer.

4.15 Regulation of X-axis Zero Point

The positioning of Y-axis zero point can be carried out by limiting baffle on Y-axis together with Y-axis positioning optical coupler on Z-axis control board. When it moves to the limiting baffle and block the detecting optical coupler, Z-axis control board detects the voltage change feedbacked by optical coupler and determines the zero point is reached, and stops moving. Regulation of Y-axis positioning is mainly for limiting the position of the baffle.

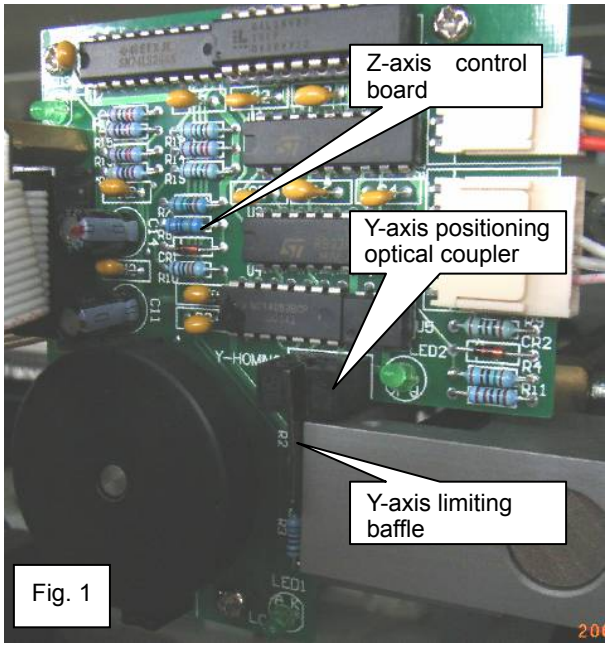


Fig. 1

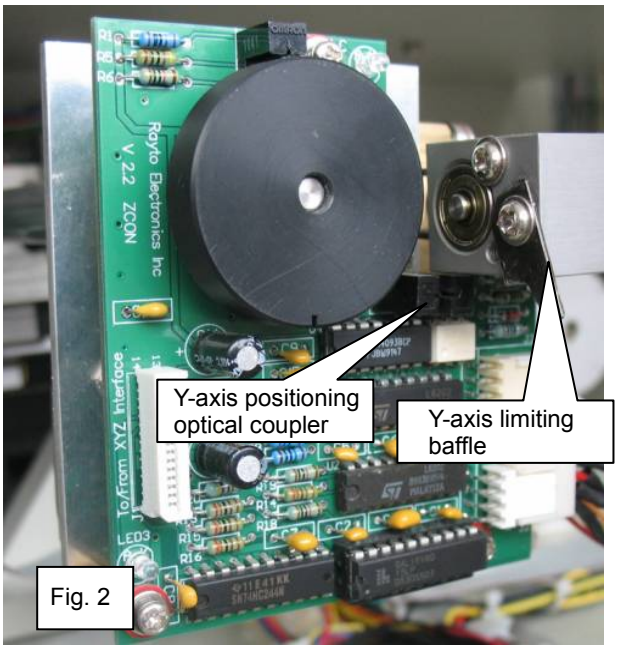


Fig. 2

Fig. 1 shows the installation method of Z-axis control board of the old version; Fig. 2 shows the installation method of Z-axis control board of the new version. Comparing with Fig. 1, the installation directions of the two methods are opposite, but the regulation principle is the same.

The regulation method is as follows:

1. Switch off the analyzer, and lift the rear cover of the analyzer.
2. Move the Sampling head to the original position (the sample probe just faces towards the waste liquid hole). At this time, observe the positions of Y-axis positioning optical coupler and limiting baffle, the limiting baffle should just block the middle of the optical coupler. If not, you can adjust the position of limiting baffle.
3. After the adjustment, start up the analyzer to check the Y-axis position during start-up self-test. If an offset exists, you should go on adjusting. If the probe feed position is accurate, the regulation is complete, close the rear cover of the analyzer.

4.16 Regulation of Z-axis Zero Point

The positioning of Z-axis zero point can be carried out by Z-axis encoding disc on Z-axis together with Z-axis positioning optical coupler on Z-axis control board. Z-axis control board detects the feedbacked voltage signal change and determines the operation of sample probe or stirring rod. Z-axis positioning is mainly for regulation of Z-axis encoding disc position.

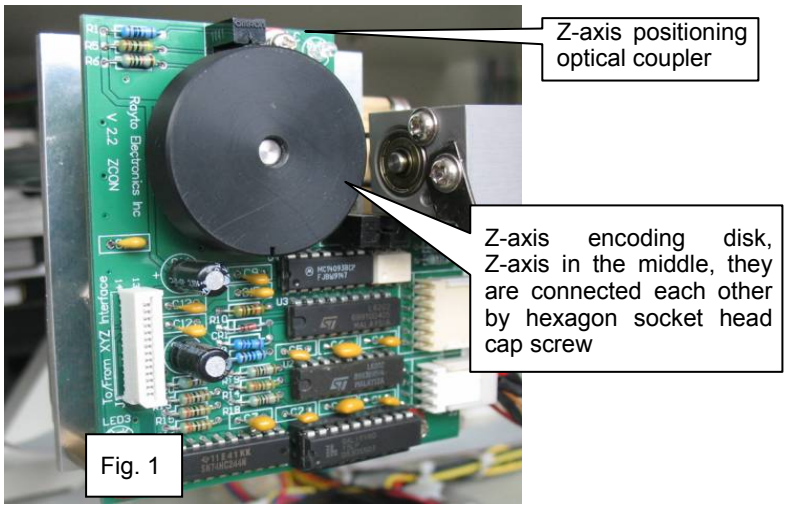


Fig. 1

The regulation method is as follows:

1. Switch off the analyzer, lift the rear cover of analyzer and remove the plastic cover on sampling head.
2. Loosen the hexagon socket head cap screw for connecting the Z-axis encoding disc to Z-axis, remove the Z-axis encoding disc.
3. Adjust the Z-axis until it is perpendicular to the plane, as shown in Fig. 2.

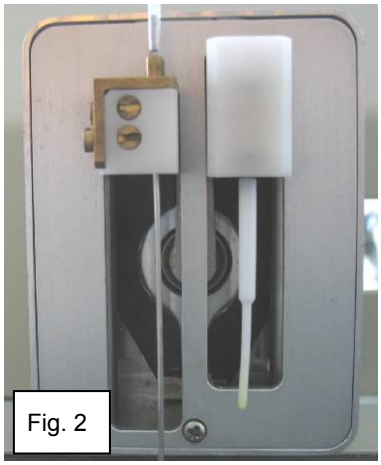


Fig. 2

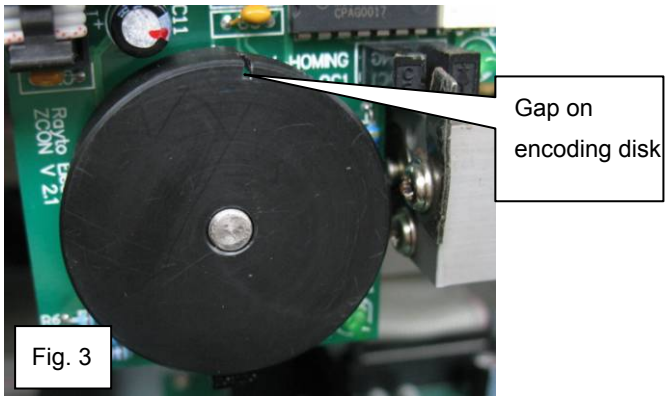


Fig. 3

4. Install Z-axis encoding disc to the Z-axis in the same way, the surface with a gap should be upwards (perpendicular to the horizontal plane), fix the hexagon socket head cap screw for fixing the encoding disc to Z-axis, fix the encoding disc securely.
5. Turn the Z-axis encoding disc at the rear of the analyzer by hand, and check if the sample probe and stirring rod move freely. If they move freely, the next procedure can be carried out; if not, you should reinstall them.
6. Install the plastic cover on sampling head, and install the rear cover of the analyzer.
7. Start up the analyzer and enter the backdoor program to test the probe-feed concentration of Z-axis, the probe-feed concentration of Z-axis can be adjusted by fine adjustment of Z-axis.

Note: The installation direction of Z-axis control board of new version is just opposite to the one of the figure. Before carry out the procedure 4, you should let the surface with a gap downwards (perpendicular to the horizontal plane), and install to the Z-axis. However, the other procedures are the same.

5. Maintenance

RT-200C Plus is a precision clinical analyzer. For ensuring its good conditions, daily maintenance should be done. Maintenance of RT-200C Plus is very simple, but it should be carried out carefully.

5.1 Basic Maintenance

Cleaning of the analyzer surface:

1. Keep the operating environment of the analyzer clean.
2. Neutral detergent and wet cloth can be used for cleaning the surface of analyzer.
3. Please use a soft cloth to clean the LCD.

Daily maintenance

1. Empty the waste bottle
2. Fill the lotion bottle
3. Check if the printer paper is sufficient

Half-year maintenance

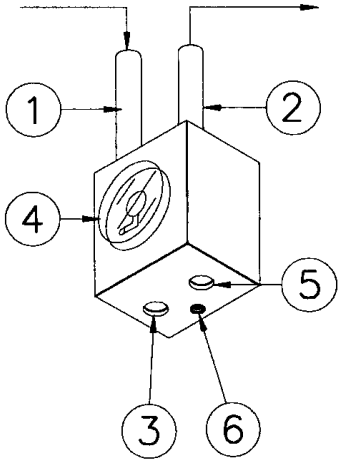
1. Replace the pump tube for the peristaltic pump
2. Rinse the cleaning flowcell: add several milliliter of dilute bleaching agent (5:1000)
3. The minimum design life of photometer bulb is 2000 hours, you should replace the bulb with a new one when the time comes.

5.2 Maintenance of Flow Cell

The flowcell installed inside is made of stainless steel, of which precision is high, temperature rises quickly and constant temperature is accurate. Temperature conversion is carried by Peltier which ensure the internal temperature of flow cell is constant quickly.

Characteristic:

- Volume: 50uL
- Window diameter: 7.5mm
- Optical path: 10mm
- Weight: 10g



Structure diagram of flow cell

①Inlet of flowcell ②Outlet of flowcell

③Temperature sensor ④Colorimetry window

⑤Temperature sensor ⑥Fixing screw

5.2.1 Cleaning of Flow Cell

After testing, the system will rinse the flowcell once automatically to avoid bacterium in the flowcell. Daily cleaning of the flow cell by sanitizer for glassware (Tween 20 of 1:20 can be used too) is recommended.

Procedures:

1. Start up the system
2. Run system maintenance program (or backdoor program of the analyzer), insert the probe to sanitizer, and then press MANUAL PUMP key to aspirate sanitizer to the flowcell (by pressing down the key for 10 seconds).
3. Keep the sanitizer in the flowcell for 15 minutes.
4. Repeat procedures 2 and 3 once.
5. Rinse the flowcell by distilled water for 1 minute and exit.

5.2.2 Method for Handling the Blocked Flowcell

If the sample serum isn't processed well and the sample contains fibrinogen, the sampling/sample adding probe and flowcell will be easily blocked, so that the analyzer can't aspirate normally. The unblocking method is as follows:

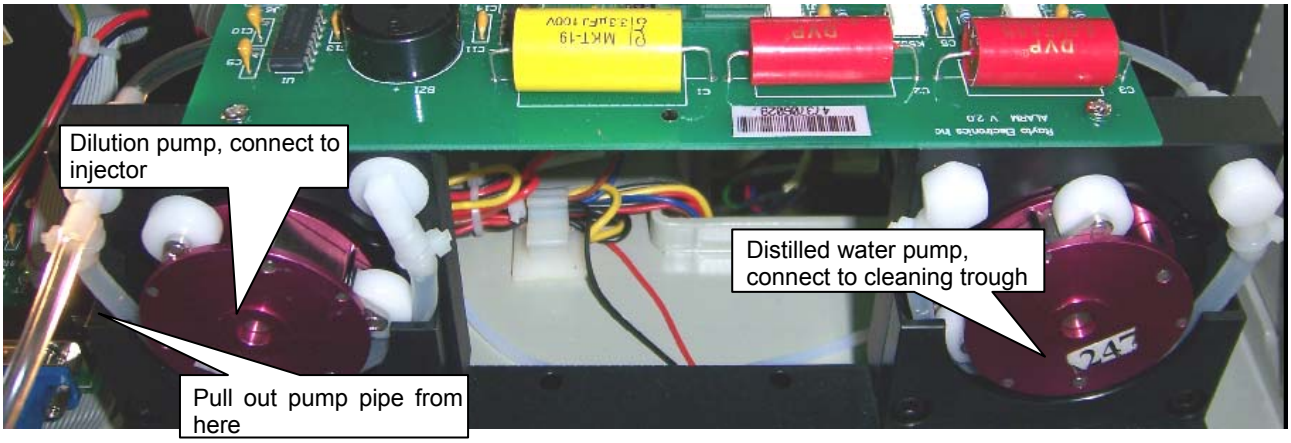
1. Switch off the analyzer, and remove the rear cover of the analyzer.
2. Pull out the connecting tube between flowcell outlet tube and flowcell peristaltic pump (pull out from

the end that the peristaltic pump is connected, as shown in the figure below)

3. Prepare a 10ml injector to aspirate distilled water, install it with a pipette, fill in the outlet tube be pulled out just now, push the injector to inject the water into flowcell, repeat the procedures above until water flow out from sampling probe of Sampling head freely. (If water flows in from the flowcell bottom, quartz piece of the flowcell has dropped, the flowcell should be replaced).

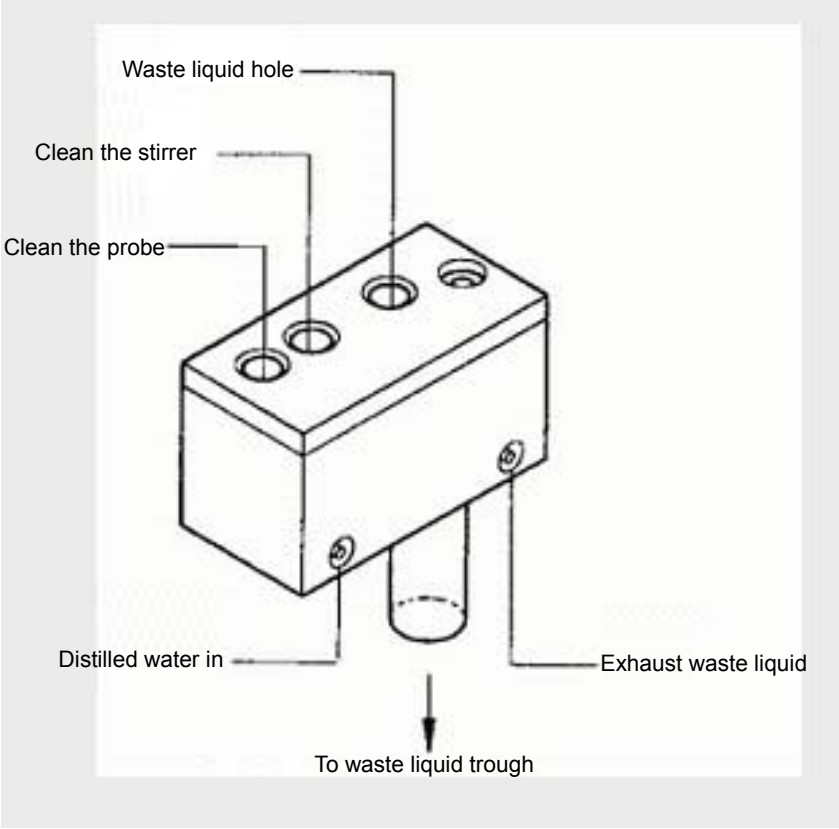
5.3 Method for Handling the Blocked Sampling Probe

1. Switch off the analyzer, and lift the rear cover of the analyzer.
2. Remove two hexagon socket head cap screws on pump baffle, remove the pump baffle, and pull out one end of the pump tube as shown in figure.
3. Prepare a 10ml injector to aspirate distilled water, install it with a pipette, fill in the outlet tube be pulled out just now, push the injector to inject the water into flowcell, repeat the procedures above until water flow out from sampling probe of Sampling head freely.



5.4 Cleaning the Probe and Trough

Clean the cleaning trough once each month. Fill the cleaning trough with 5:1000 bleaching agent, and keep the agent for 15～20 minutes, and then rinse the trough with a large amount of distilled water.



Structure diagram of cleaning trough

5.5 Calibration the Pumped Liquid Amount of Flowcell

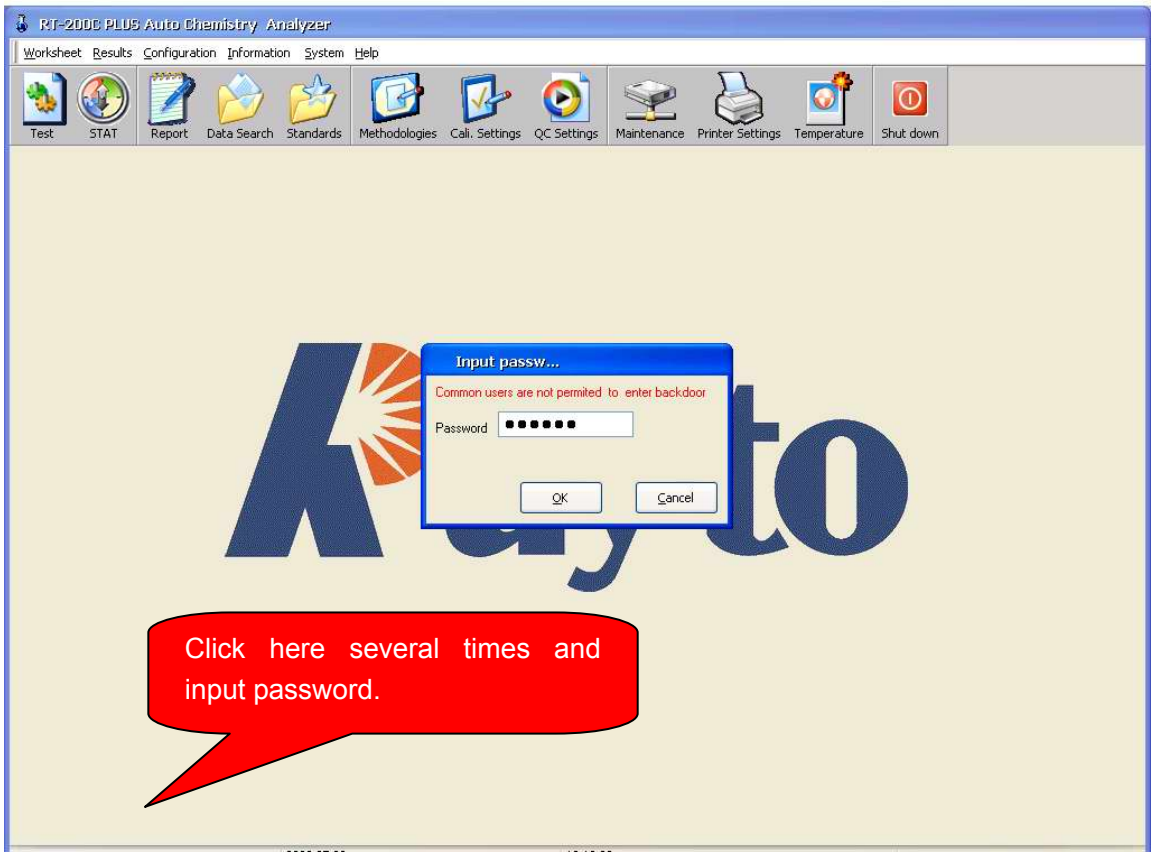
Calibration for the pumped liquid amount of flowcell is very important, it can affect the aspirate amount and the position where the reaction liquid passes through the flowcell, and decide whether air or reaction liquid reaches the flowcell during color comparison, so it affects the test result directly. It can be carried out according to the procedures below.

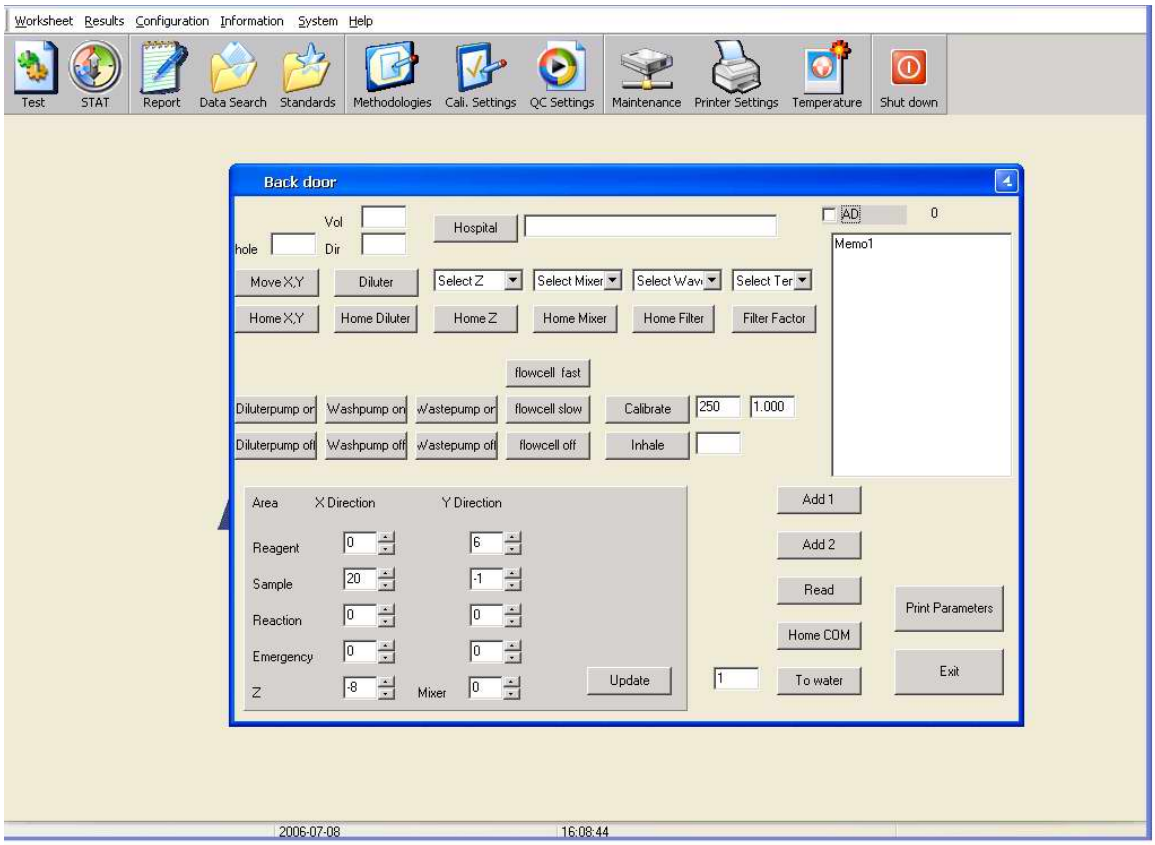
1. Start up the analyzer to enter the backdoor program.
2. Calibration the aspirate amount of pump first, move X-axis to one reaction after adding 450ul water to the reaction position, feed Z-axis probe and click “Quantitative Aspirate” after reaching the position of quantitative aspiration. When the aspiration is complete, observe the amount of residual liquid in reaction cup which should be less than 50ul. If it is more than 50ul, the designation factor of pump can be increase for increasing the aspiration amount. If air is aspirated during aspirating liquid, the designation factor can be reduced. .
3. And then calibration the additional liquid amount. You should calibration according to the minimum reagent amount of the analyzer. Now we designate as 400ul. After adding 400ul high-concentration

color solution (generally, we use $K_2Cr_2O_7$ solution or Cre reagent) to a reaction position, move X-axis to the reaction position and feed Z-axis, click “Quantitative Aspiration” after adding 400ul at quantitative aspiration position. After the aspiration is complete, observe the position where the liquid reaches after passing through the flowcell. A section of liquid without bubble should be kept at both ends of the flowcell (1/2 or 2/3 of liquid should pass through the flowcell). If there is less liquid at the first half, there is more liquid at the second half, so you can reduce “Additional Liquid Amount” to adjust; if there is more liquid at the first half, there is less liquid at the second half, so you can increase the “Additional Liquid Amount” to adjust.

5.6 Backdoor Program Debugging

Click left button several times at bottom left corner of the main menu, backdoor password input window pops up. After inputting password “888888”, the backdoor program can be accessed.





Function of each menu is as followings:

Hole: Input hole position here, click “move XY” to move the Sampling head to the hole.

Note: Hole position of waste liquid hole of cleaning trough is 0, hole position of distilled water hole is 299, hole position of No.1 reagent position is 1, sample hole position No. is increased from reagent hole position, e.g. No.1 sample position is 37 (if the analyzer only has 27 reagent positions, No.1 sample hole is 28). The reaction hole is increased from sample hole position, STAT position hole is increased form reaction hole position.

XY-axis reset: Reset the Sampling head to the original position.

Liquid amount: Control the liquid amount of register aspiration.

Direction: Two operating state: “0” and “1”, “0” means injector aspiration, and “1” means injector injection.

Injector operation: Let the injector aspirate or inject according to the inputted liquid amount.

Injector reset: Let the injector reset to the original position.

Injector debug: Control the state of sample probe, there are several states as follows, the other states are not used.

To cup bottom: Feed the sample probe to cup bottom

To level surface: Feed the sample probe to level surface

To liquid-injected position: Feed the sample probe to liquid-injected height

Z-axis reset: Reset the Z-axis to the original position

Stirring rod debug: control the state of the stirring rod. Generally, the stirring rod has ON/OFF state, the other states are not used.

Stirring rod reset: Reset the stirring rod to the original state.

Wavelength selection: Select the desired wavelength

Filter wheel reset: Reset the filter wheel to the original state.

Temperature setting: Select the desired temperature of the analyzer

Filter factor: Set the correction factor of the filter. Generally, it is not used.

Peristaltic pump state debug: Test the operating state of peristaltic pump, switch on/off the peristaltic pump.

Addition liquid amount: After a aspiration of a certain amount of reaction liquid, a certain amount of air is required to send the reaction liquid into the flowcell. The additional liquid amount is the intaken air amount for adjustment to let the reaction liquid to the best position of the flowcell.

Designation factor: Adjust the aspiration time of flowcell peristaltic pump to measure the aspiration amount and reduce the residual amount in reaction tray.

Quantitative aspiration: Control the amount of intaken liquid of flowcell peristaltic pump, the aspiration amount can be inputted in the input box followed.

Area fine adjustment: Adjust the horizontal levels of reagent position, sample position, reaction position and STAT position, and the height of Z-axis probe feed (the less the value is, the lower the probe feeds). Click “Update” to save the parameters after adjustment.

6. Troubleshooting

Failure	Solution
The analyzer can't be started	—Is the plug loose? —Check the fuse —Check the voltage
The bulb of photometer can't be lit	—Replace the bulb before checking the power supply —If the computer and analyzer are normal, replace the bulb
Can't download program	—Shut down the analyzer for 10 seconds and restart it
The printer can't be started up	—Is the plug loose? —Check the ON/OFF button —Check the fuse
The printer can't print	—Is the connection in normal state?
No liquid in cleaning pool	—Is there no cleaning fluid in lotion bottle? —Is the peristaltic pump in normal state? —Check the delivery tube
No liquid in flow flowcell	—Is the peristaltic pump in normal state? —Check the connections of aspiration probe, flow cell inlet, etc. —The aspiration tube is too long or too short —A section of aspiration tube is aging, it should be replaced —The flow cell is dirty
No reading on photometer	—Is the bulb of photometer lit? —Try another wavelength for reading
The water blank valve is too high	—Clean the flowcell —Check the cleaning fluid —Check the bulb of photometer —Is the aspiration probe blocked?

Bad repeatability of result	—The reaction disk is dirty, it should be replaced —There is bubble in the flowcell, it should be cleaned —Check the aspiration of the flowcell —The reagent amount is less than 400ul, increase the reagent amount —Replace the bulb of the photometer —The aspiration probe isn't connected well —The reaction liquid is polluted —Is the sample amount is enough —Is the reagent amount enough
The aspiration of flow cell is not constant.	—Is the aspiration probe blocked? —The peristaltic pump may be replaced Check if the reaction disk isn't damaged and install it securely
Quality control is not in target range	—Check the effective period of quality control fluid and check if it is polluted —Check the item settings to see whether the parameters are needed to changed —Retest in another way —Check the temperature of flow cell and incubator, use new reagent or quality control to measure again
Bubble in flowcell	—The tube between sample probe and flow cell is damaged or not connected well —The tube is too long or too short. —Is the connection of the tube in normal state?
Bubble in injector	—Check the sealing of the piston and leakage of gas —Use Tween 20 solution to clean the injector (2 drops/L of distilled water) —Replace the O-ring inside injector —Check the tubeline connected to injector
Polluted sample	— A leakage occurs to sample probe resulting from bad connection —Clean it properly or replace the probe —Clean the rinsing trough —Is there residual liquid on the probe? —Is the cleaning fluid new or not polluted? —Clean the flow cell

	—Rinse it twice when item setting —The reaction tray is dirty, replace it with a new one —The sample cup is dirty, replace it with a new one
The temperature of incubator is too low	—Check the temperature setting, and adjust it to 37℃
A leakage of liquid occurs to the bottom of the analyzer	—Is the outlet tube for waste liquid inserted into the waste bottle? —Overflow from waste bottle —The rinsing trough is blocked

If a failure occurs, please contact to agency or Rayto in time to get technical support!

【RT-200C Plus: Calculation item settings】

For calculation item, its name and number code should be write according to the codes below; otherwise, the calculation item can't be displayed.

1. GLB =TP –ALB ALB/GLB ratio
2. TBILI – DBILI = IBILI
3. AST/ALT AST/ALT ratio
4. LDH/AST LDH/AST ratio
5. GGT/AST GGT/AST ratio
6. ApoA/ApoB ApoA/ApoB ratio
7. LDL = CHOL – HDL –TRIG /2.2

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