BC-2300

Hematology Analyzer

Service Manual

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NOTE

- **This equipment is not intended for family usage.**
- **This equipment must be operated by skilled/trained medical professionals.**

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- **It is important for the hospital or organization that employs this equipment to carry out a reasonable service/maintenance plan. Neglect of this may result in machine breakdown or injury of human health.**

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2. Freight policy. The customer is responsible for freight charges when equipment is shipped to Mindray for service (this includes customs charges).

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Table of Contents

1 Using This Manual

Introduction

This chapter explains how to use your BC-2300 service manual, which provides the reference information and procedures needed for servicing your BC-2300 analyzer. Read this manual carefully before servicing your analyzer and service your analyzer strictly as instructed in this manual.

This manual is to be used in conjunction with the BC-2300 analyzer operation manual and does not contain information and procedures already covered in the operation manual.

NOTE

- **Be sure to service your analyzer strictly as instructed in this manual and the operation manual.**

Who Should Read This Manual

This service manual is written for people who

- have a thorough understanding of electronic and fluidic principles.
- have a thorough understanding of reagent systems.
- have a thorough understanding of quality control.
- have a thorough understanding of troubleshooting concepts.
- have an operator's knowledge of the analyzer.
- have the ability to use basic mechanical tools and understand related terminology.
- have the ability to use a digital voltmeter (DVM) and an oscilloscope.
- have the ability to read electronic and fluidic schematics and understand related terminology.

How to Find Information

This operation manual comprises 8 chapters and 2 appendices. Refer to the table below to find the information you need.

If you want to…	**See…**
learn about the hardware and how to test the boards of BC-2300	**Chapter 2 Hardware**
learn about the system structure and how to disassemble/replace parts and components of BC-2300	**Chapter 3 Disassembling/Replacing Parts and Components**
learn about how fluidic system functions	**Chapter 4 Fluidic System**
learn about how passwords function and how to upgrade the BC-2300 software	**Chapter 5 Software**
learn about the histograms and pulse graphs	**Chapter 6 Histograms and Pulse Graphs**
learn about how to troubleshoot your BC-2300	**Chapter 7 Troubleshooting**
learn about the main spare parts of BC-2300	**Chapter 8 List of Spare Parts**
learn about the schematic diagram of the fluidic system	**Appendix A Fluidic Diagram**
learn about the correspondence between errors and error codes of BC-2300	**Appendix B Error Code Description**

Conventions Used in This Manual

This manual uses certain typographical conventions to clarify meaning in the text:

- **n** All capital letters enclosed in [ ] indicate a key name (either on the built-in keypad or the external keyboard), such as [ENTER].
- **n** All capital, bold and italic letters indicate a special operation defined in the following section, such as ***SELECT***.
- **n** Bold letters included in " " indicate text you can find on the screen, such as "**Prepare to ship**".
- **n** Bold letters indicate defined screen areas/fields, such as **System Status** area, or chapter titles, such as **Chapter 1 Using This Manual**.

All illustrations in this manual are provided as examples only. They may not necessarily reflect your analyzer setup or data displayed.

Special Terms Used in This Manual

When you read …	It means …
CLICK	to press the arrow keys ([←][→] [↑][↓]) as needed to move the cursor to a certain software button on screen and press [ENTER].
ENTER	to press the arrow keys ([←][→] [↑][↓]) as needed to move cursor to the desired edit box and use the built-in keypad or the external keyboard to enter the desired characters or digits. Note that besides the numeric keys you may also use the [PgUp] or [PgDn] keys to enter digits; or to scan the number using the bar-code scanner.
DELETE	to press the arrow keys ([←][→] [↑][↓]) as needed to move the cursor to the character or digit to the left of the one you want to delete and press [DEL]; or to press the arrow keys ([←][→][↑][↓]) as needed to move the cursor to the character or digit to the right of the one you want to delete and press [BackSpace] on the external keyboard.
MODIFY	to move the cursor to the character or digit you want to change and re-enter the desired one using either the built-in keypad or the external keyboard.
SELECT from " ** " pull-down list	to press the arrow keys ([←][→] [↑][↓]) as needed to move the cursor to the desired edit box and press [ENTER] to display the pull-down list and press [↑] or [↓] to move the cursor to the desired item and press [ENTER] to select it.
SELECT	to press the arrow keys ([←][→] [↑][↓]) as needed to the desired item and press [ENTER].

NOTE

- **This analyzer adopts a fixed decimal point. You can enter the digits without bothering to look for the [.] on the external keyboard.**

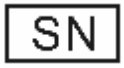
Symbols

You will find the following symbols in this manual.

When you see…	Then…
⚠ WARNING	read the statement below the symbol. The statement is alerting you to an operating hazard that can cause personnel injury.
⚠ CAUTION	read the statement below the symbol. The statement is alerting you to a possibility of analyzer damage or unreliable analysis results.
NOTE	read the statement below the symbol. The statement is alerting you to information that requires your attention.
	read the statement below the symbol . The statement is alerting you to a potentially biohazardous condition.

You may find the following symbols on the analyzer or the reagents.

When you see…	It means…
	EQUIPOTENTIALITY
	CAUTION, CONSULT ACCOMPANYING DOCUMENTS.
	BIOLOGICAL RISK
	HIGH VOLTAGE
IVD	IN VITRO DIAGNOSTIC
	ALTERNATING CURRENT

	USE BY
	SERIAL NUMBER
	DATE OF MANUFACTURE
	TEMPERATURE LIMITATION
	CONSULT INSTRUCTIONS FOR USE
	THE DEVICE IS FULLY CONFORMANCE WITH THE COUNCIL DIRECTIVE CONCERNING IN VITRO DIAGNOSTIC MEDICAL DEVICES 98/79/EC.
	MANUFACTURER
	AUTHORISED REPRESENTATIVE IN THE EUROPEAN COMMUNITY
	IRRITATING SUBSTANCE
	THE FOLLOWING DEFINITION OF THE WEEE LABEL APPLIES TO EU MEMBER STATES ONLY: THE USE OF THIS SYMBOL INDICATES THAT THIS PRODUCT SHOULD NOT BE TREATED AS HOUSEHOLD WASTE. BY ENSURING THAT THIS PRODUCT IS DISPOSED OF CORRECTLY, YOU WILL HELP PREVENT BRINGING POTENTIAL NEGATIVE CONSEQUENCES TO THE ENVIRONMENT AND HUMAN HEALTH. FOR MORE DETAILED INFORMATION WITH REGARD TO

	RETURNING AND RECYCLING THIS PRODUCT, PLEASE CONSULT THE DISTRIBUTOR FROM WHOM YOU PURCHASED THE PRODUCT.

2 HARDWARE

Electronic unit

Position of Electronic Unit

Located inside the analyzer, the electronic unit comprises CPU board, analog board and drive board, as shown in figure 2-1.

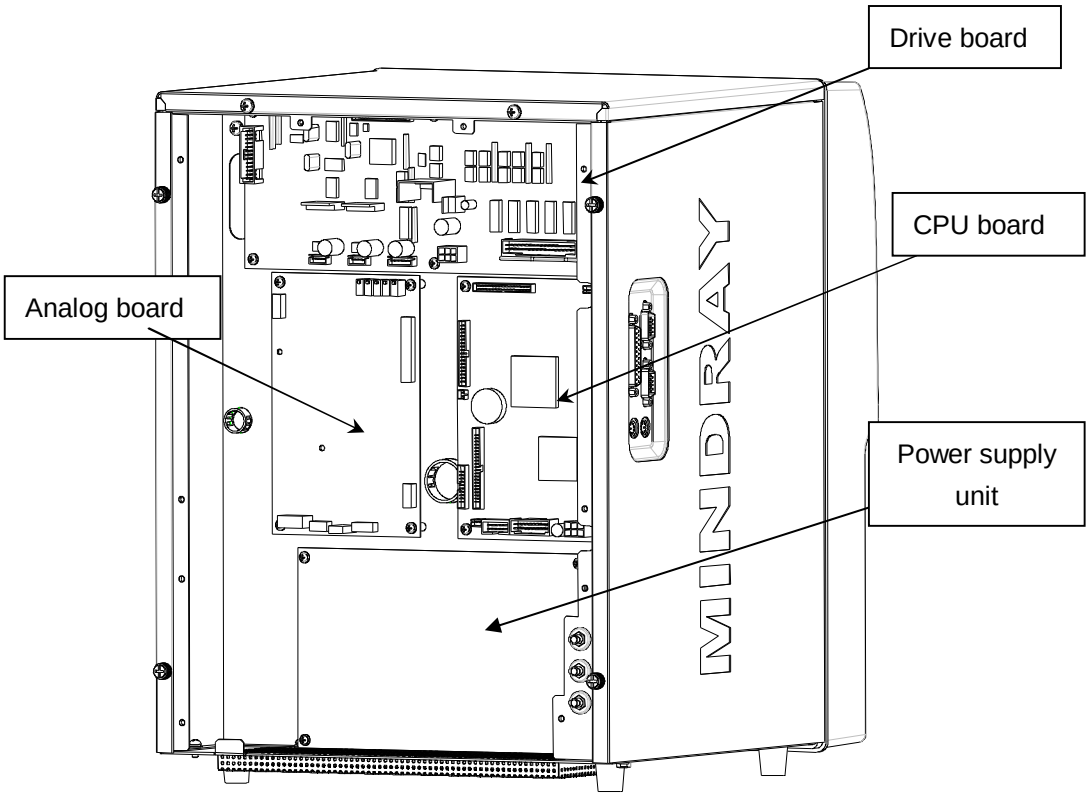


figure 2-1 inside back of the analyser

The boards are fixed directly by screws. The drive board is fixed with 6 M3 screws, while both the CPU board and analog board are fixed with 4 M3 screws respectively. The drive board is 2mm away from the CPU board and analog board, which are separated by about 27mm.

The volumetric unit is located above the vacuum chamber assembly, as shown in figure 2-2.

The upper end of the metering tube is connected to the solenoid valve by a T-piece, while the lower end to the vacuum chamber unit by a hose. The metering tube itself is fixed on the volumetric unit by 2 brackets. Together with the metering tube, the pot on the metering tube can be adjusted to ensure correct level signals.

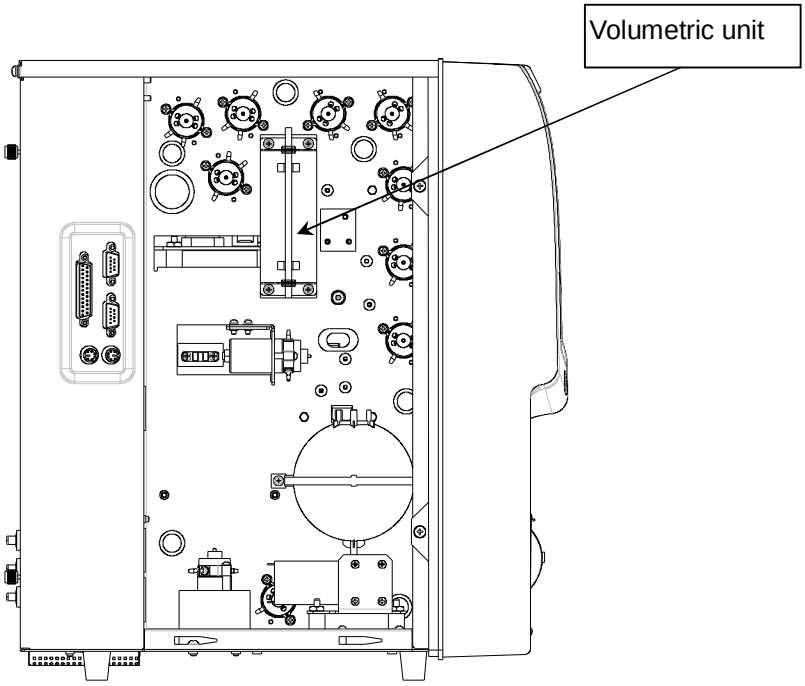


figure 2-2 Volumetric unit

Panels consist of main user interfaces, such as recorder unit (recorder drive board), keypad, indicator board and screen unit (LCD, inverter and LCD adapter), as shown in figure2-3.

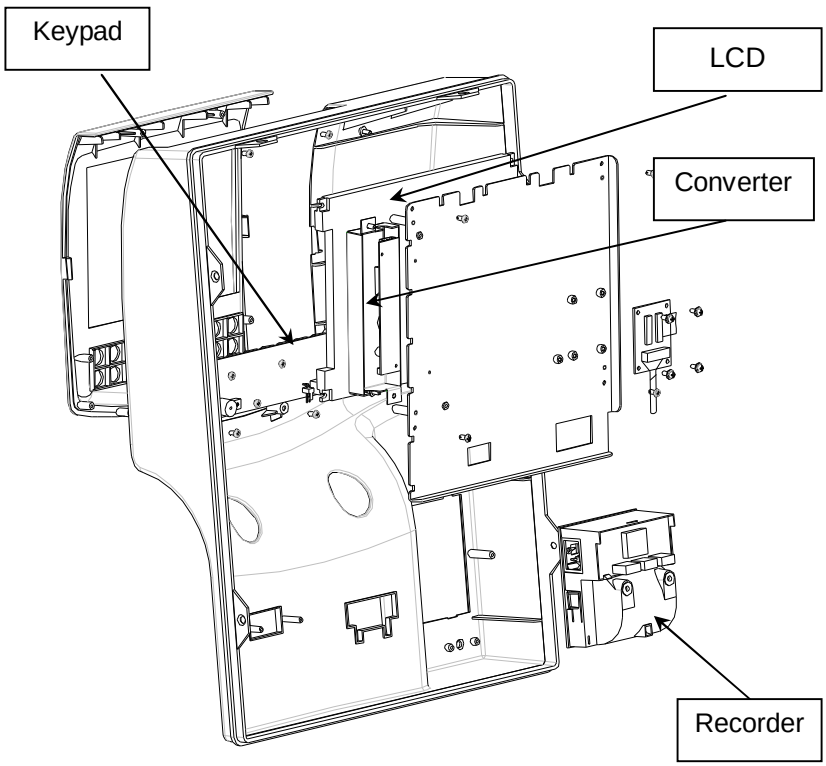


figure 2-3 Panels disassembly view

Schematic of Electronic Unit

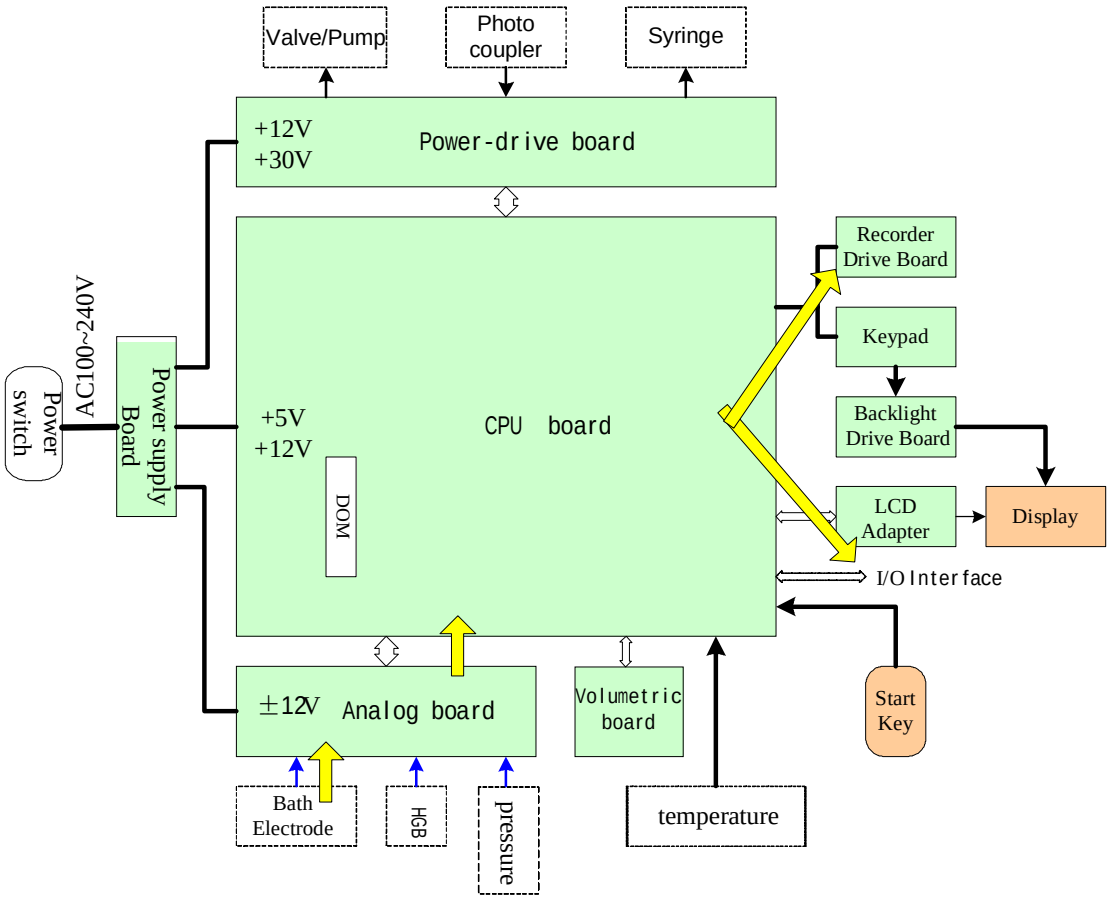


figure 2-4 Schematic of Electronic Unit

CPU Board

Schematic

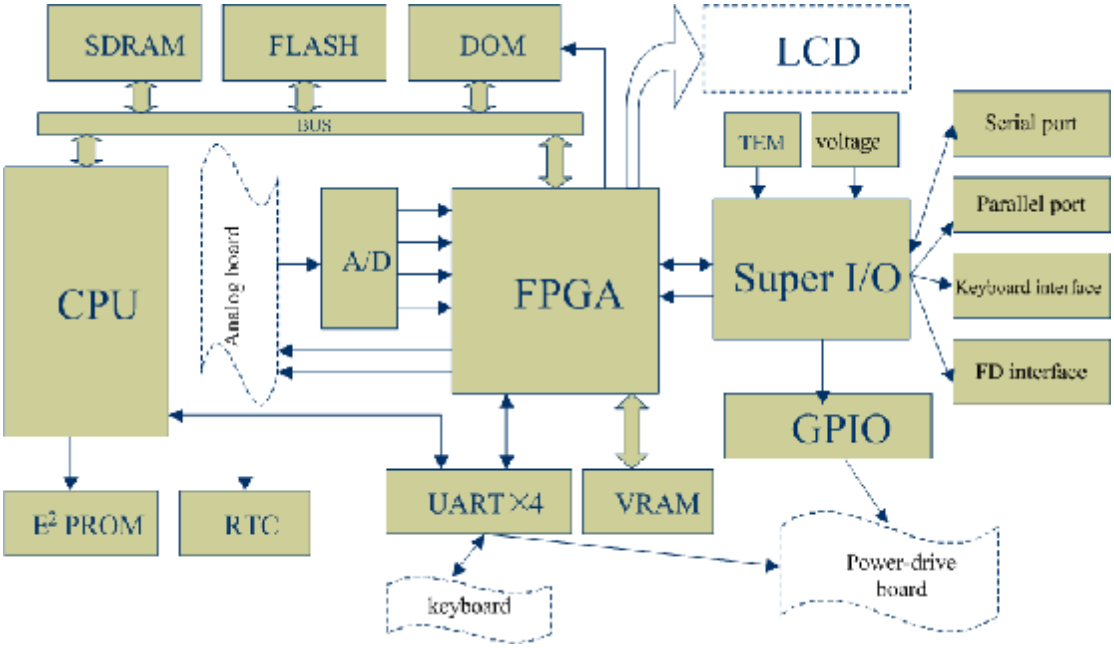


figure 2-5 Schematic of the CPU board

The CPU, FPGA and Super I/O are the major components on the board. The CPU carries out the instructions and functions as the core of the board. The FPGA functions as the relay between the CPU and the Super IO. The Super I/O includes various interfaces that can be accessed by the CPU through the FPGA. System memories are SDRAMs. The DOM is a Disk-On-Module that stores the system software and test data. The RTC is a real time clock. System configurations are stored in the EEPROM. The VRAM is the memory for video display.

Basic Functions

To receive such analog signals as the WBC/RBC+PLT counts, HGB measurement, aperture voltage, vacuum/pressure signals, etc.

To monitor such system status as the +56V, +12V and -12V supplies of the analog board, the +3.3V and +12V supplies of the CPU board itself and the temperature of the whole analyzer.

To receive the keypad signal and control the keypad buzzer and LCD backlight.

To generate control signals to control the pump/valves, aperture zapping, HGB LED, current source and digital pot.

To drive and turn on the LCD and adjust the contrast.

To drive the keyboard, printer and floppy drive.

Power Supply

The CPU board is powered by two independent external power supplies, a +5V supply and a 12V supply. Two 5A fuses are respectively installed on the two power entries. The +5V supply is converted a +3.3V supply to power the digital components and the +3.3V supply is also further converted into a +1.5V supply to power the FPGA. The +12V supply serves the CPU board only.

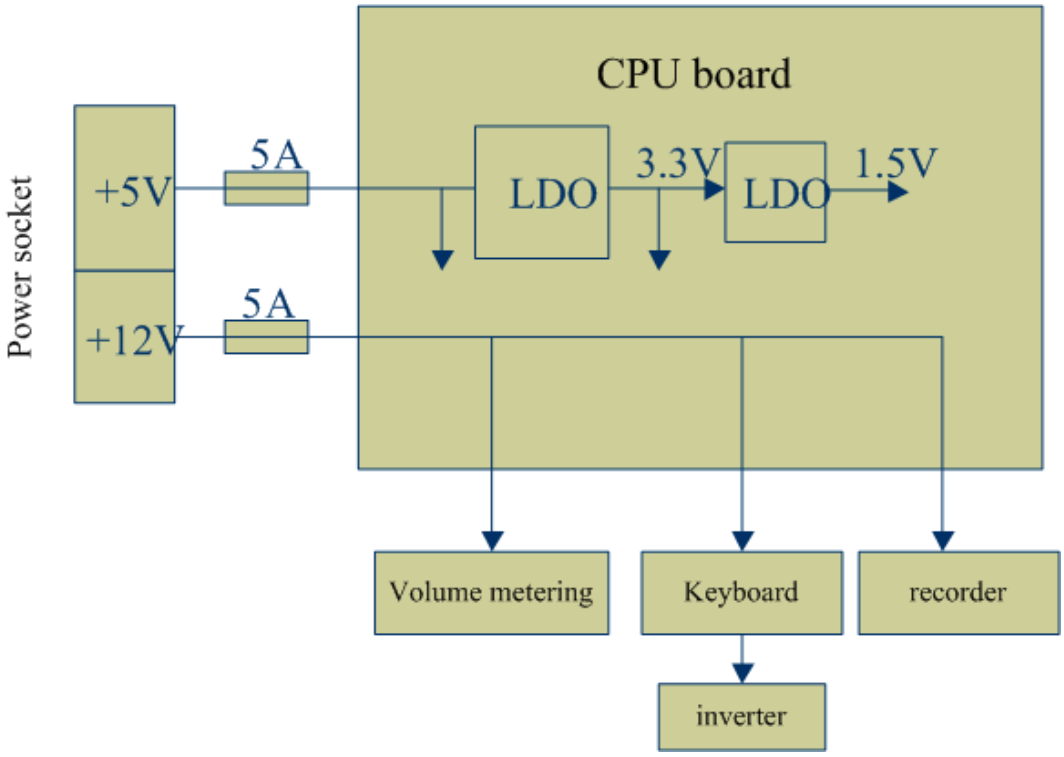


figure 2-6 Power distribution of the CPU board

RTC

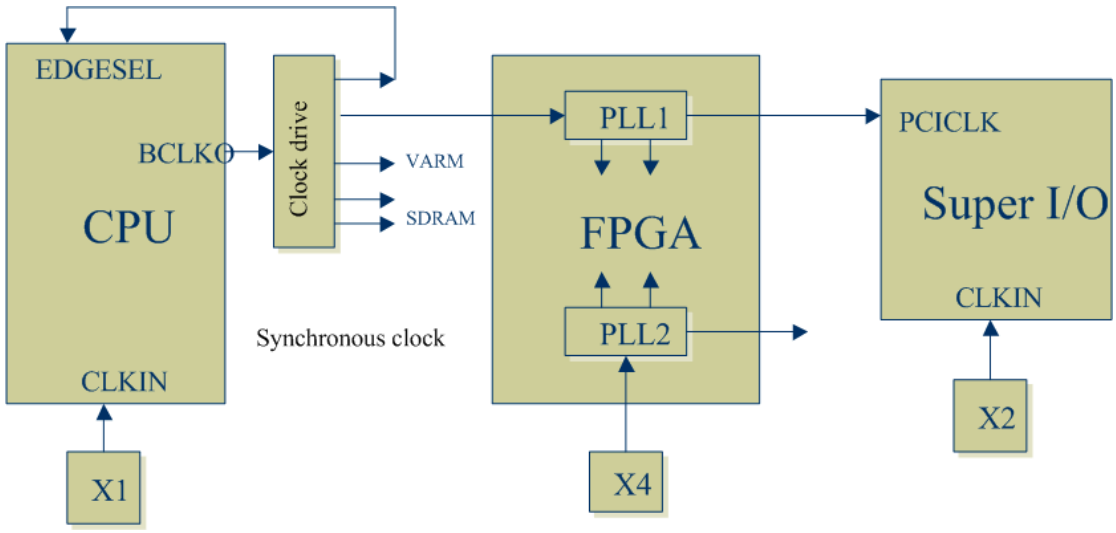


figure 2-7 Arrangement of the CPU Clock

The X1, X4 and X2 are external crystal oscillators whose frequencies are 45MHz, 45MHz and 24MHz respectively. The clock output of the CPU, BCLKO, is main clock signal of the CPU board.

CPU and Peripheral Devices

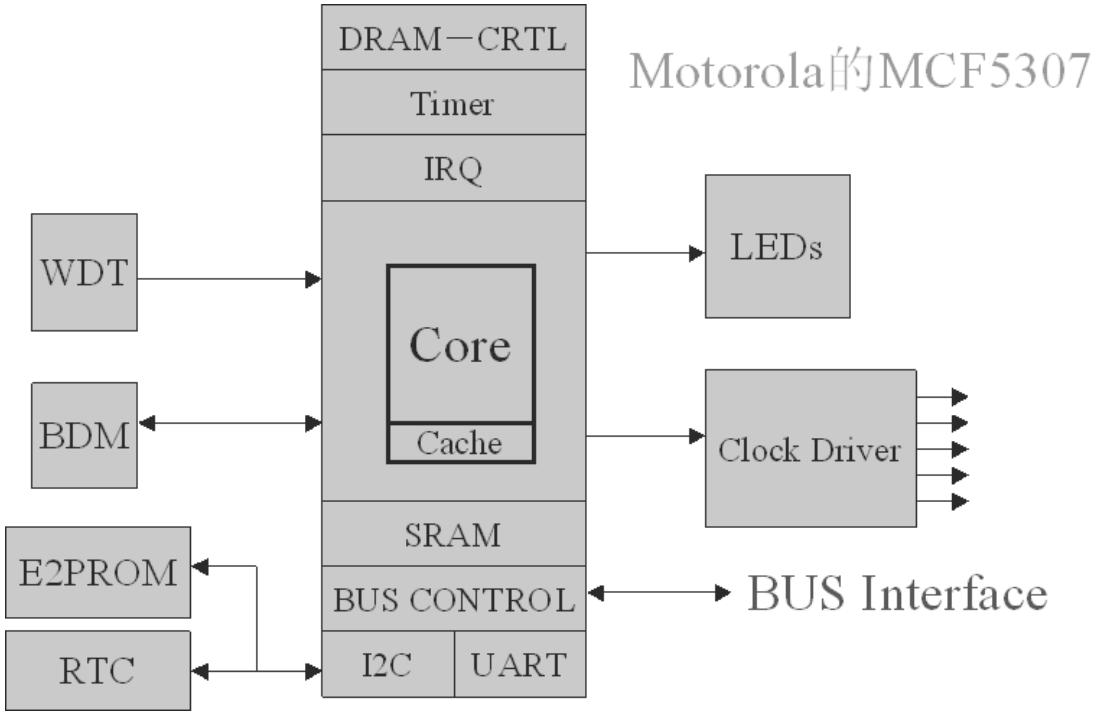


figure 2-8 CPU and peripheral devices

1. CPU

- The CPU is MOTOROLA MCF5307 (external frequency 45MHz; operation frequency 90MHz; processing speed as high as 75MIPS).
- The MCF5307 features a 32-bit data bus and a 32-bit address bus. The board uses a 24-bit addressing mode, reserving the most-significant 8 bits as the general purpose I/Os for the FPGA.
- The MCF5307 can be tuned through the BDM port (J18 of the CPU board).
- The CPU board utilizes the built-in I^2C and UART controllers of the MCF5307 to use the EEPROM and RTC as expanded serials ports.
- The CPU boards utilizes the built-in DRAM controller of the MCF5307 to use the 2×8M SDRAM as the expanded memory.

2. WDT

The Watch-Dog-Timer (WDT) is TI TPS3828. It monitors the running of the software. The CPU must send a feedback to the WDT every 1.6s, otherwise the WDT will force the CPU to restart.

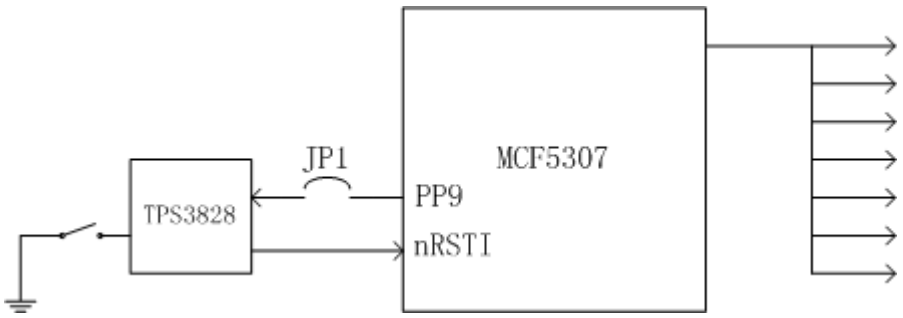


figure 2-9 WDT

3. FLASH

The FLASH is TE28F160(2M bytes) . The boot program is stored in the FLASH, so the FLASH is also called the BootROM. Every time the system is powered on, the CPU first executes the boot program that initializes the system and loads the control software from the DOM. The FLASH also contains such information as the FPGA configuration, FPGA version and LCD contrast.

4. SDRAM

The system memory consists of two 8M-byte memories.

5. DOM

The CPU board uses a 32M DOM that is powered by a 3.3V supply (the DOM can also be supplied by 5V supply). The DOM is only operational after the FPGA is configured.

6. RTC

The CPU board uses a real time clock (RTC) to record the time. The RTC is connected to the I^2C bus of the CPU board and synchronized by a 32.768KHz crystal oscillator. When the analyzer is powered on, the RTC is powered by the CPU board; when the analyzer is powered off, it is powered by the built-in battery.

7. EEPROM

The CPU board uses an 8K byte EEPROM to store such information as system configurations and settings. It is connected to the I2C bus of the CPU and can be written by CPU on-line.

8. LEDs

When D1 is on, it means +3.3V is functioning properly. When D9 is on, it means +12.8V is functioning properly. When D5 is on, it means the system is reading or writing the DOM. When D7 is on, it means the FPGA has been configured and is functioning properly. When D20 is on, it means the FPGA is restarting; The D11～D18 indicate the system status as defined by the software.

Analog Inputs and Outputs

1. Signals of Blood Cell Counts

The CPU board has three A/D converters, U10 (AD7928), U11(AD7908) and U14 (AD7908). Both the AD7928 and AD7908 feature 8-channel and 1MSPS, only the former is 12-bit converter and the latter 8-bit. The U10 is actually installed and powered by a 2.5V supply, while the U11 and U14 are reserved. The sampling speed is set to 500KSPS.

2. Signals of System Monitoring

The Super I/O monitors such system status as the +56V, +12V and -12V supplies of the analog board, the +3.3V and +12V supplies of the CPU board itself and the temperature of the whole analyzer.

3. Signals of LCD Contrast

The Super I/O generates PWM signals that are then integrated to output a 0~2.5V analog signal to control the LCD contrast. The user can adjust the contrast through the software interface.

Digital Inputs and Outputs

1. Serial Port

The analyzer has 6 serial ports, which are illustrated in Figure 2-10.

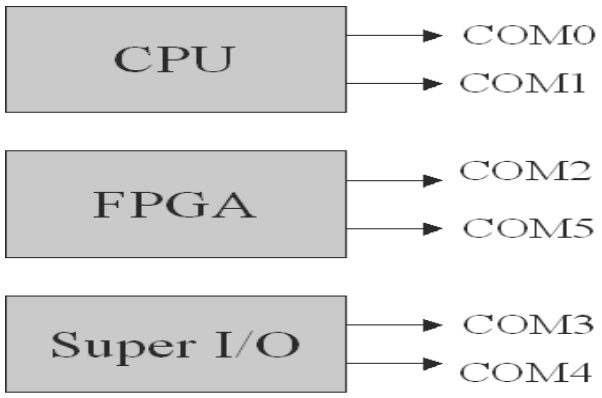


figure 2-10 Serial Ports

The CPU incorporates 2 UART controllers (3.3LVTTL), one to control the motor of the driving board and the other communicates with the recorder (powered by 5VTTL). The FPGA implements 2 UART (3.3VTTL), one to connect the keypad and the other reserved to control the pump. Another 2 UARTs (RS232) are implemented inside the Super I/O to connect the scanner and to communicate with the PC.

2. Parallel Port and PS/2 Port

The Super I/O provides a DB25 parallel connector to connect to connect a printer or a floppy drive (the power supply of the floppy drive is supplied by the PS/2). The software will automatically adapt to the connected printer or the floppy drive.

The Super I/O provides a keyboard interface and a mouse interface (COM3 and COM4). Note that the BC-2300 does not support the mouse yet.

3. GPIOs

n Signals of the Start key

The FPGA detects the input signal, which will turn low when the Start key is pressed.

n Volumetric Signals

The FPGA detects the signals sent by the start transducer and the end transducer.

n Signals of level detection

The BC-2300 has not level sensors.

n Digital pot

The SPI bus interface implemented by the FPGA controls the 4 digital potential-meters on the analog board to control the HGB gain.

n Signals controlling valves and pumps

The Super I/O outputs 20 control signals to control the valves and pumps through the driving board. Since the BC-2300 only has 1 pump and 10 valves, the redundant lines and ports are reserved.

n Signals controlling bath

The Super I/O outputs 4 control signals (through the analog board) to control the three switches that respectively control the aperture zapping, current source and HGB LED.

n Others

The Super I/O outputs 2 control signals to control the photo-couplers of the volumetric metering board and the buzzer of the keypad.

Drive Board

The drive board mainly deals with the pumps/solenoid valves drive as well as motor control and drive.

Basic Functions

The drive board drives the valves, pumps and motors of the BC-2300. It carries out the following instructions sent by the CPU: to open/close the pumps or solenoid valves; to control the motors of the syringes.

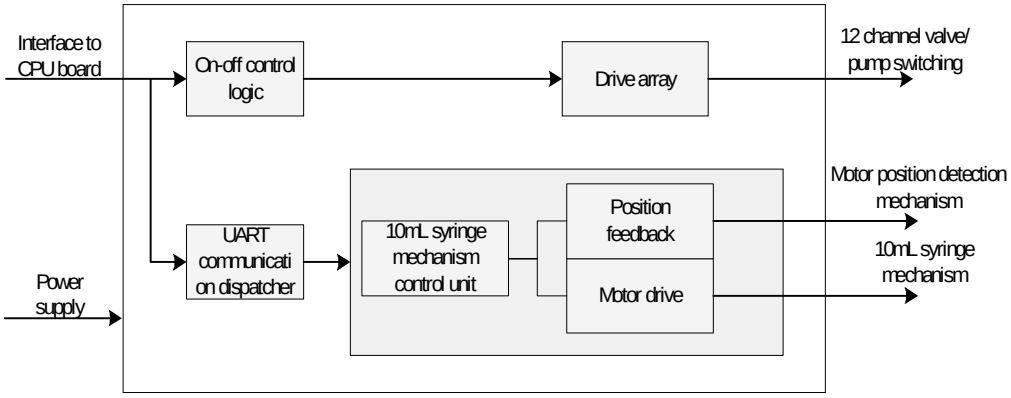


figure 2-11 Basic functions

Basic Units

The drive board mainly consists of a power supply module, on-off control module and motor control module. Each module comprises different units. See the following figure for the location of each unit on the PCBA.

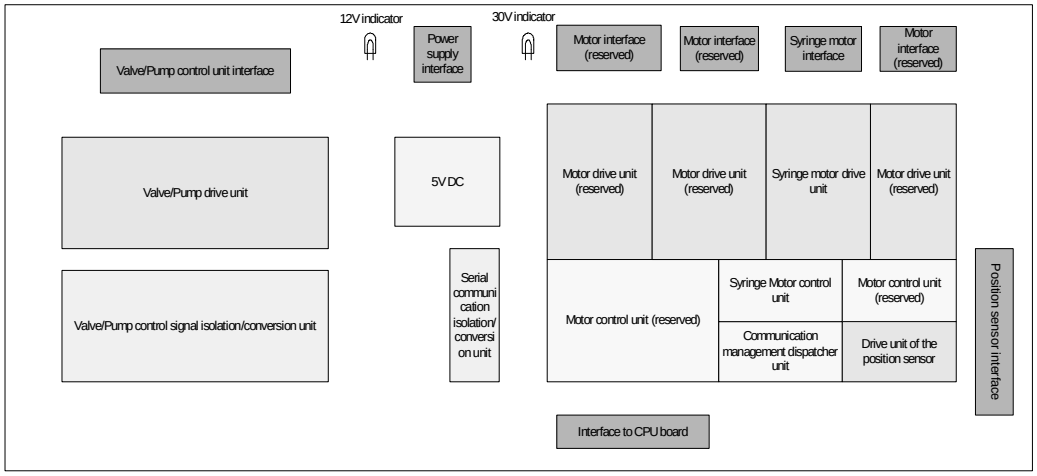


figure 2-12 Basic modules

1. Power Supply Module

The power supply Module includes a 5V, 12V and 30V DC. The 12V and 30V supply comes from the power interfaces, where two LEDs are installed to respectively indicate whether the 12V or 30V supply is connected. When the LED is on, it indicates the corresponding power has been connected to the drive board. The L7805CV converts the received 12V supply into the 5V supply, as shown in the figure below.

figure 2-13 5V power supply circuit

2. On-off Control Module

The on-off control Module mainly consists of the photocoupler circuit and drive circuit of valves and pumps, as shown in the figure below.

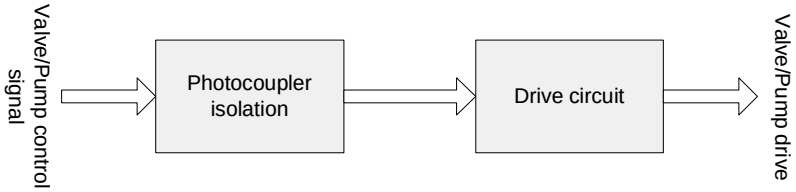


figure 2-14 On-off control module

n Photocoupler circuit

The photocoupler circuit mainly consists of the photocoupler and resistors. It provides 12 TTL outputs to the valves and pumps. The photocoupler, TLP521-2, isolates the digital ground from the power ground.

n Drive circuit of valves and pumps

The drive voltage of the valves and pumps is 12V (TTL). The circuit mainly consists of ULN2068B. In the BC-2300, the circuit can drive 10 valves and 2 pumps at most. The fluidic system decides how many pumps or valves are to be actually used.

3. Motor Control Module

The motor control unit includes: serial communication circuit, control/drive circuit of the syringe motors, and drive/signal-detecting circuit of the position sensors.

n Serial communication circuit

Since the CPU board requires a 3.3V power supply while the drive board requires a 5V power supply, a photocoupler (H11L1) is needed for the purposes of conversion and isolation. See the following figure for details.

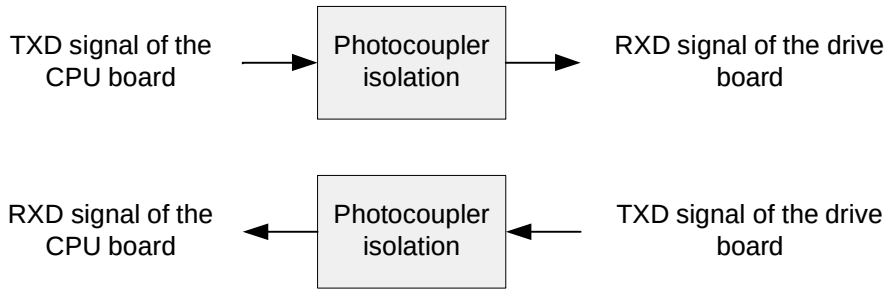


figure 2-15 Serial communication circuit

n Control/Drive circuit of the Syringe Motors

The circuit mainly consists of a control part (MCU system) and a drive part.

The MCU is the P87LPC762 with built-in WDT. The MCU system executes the aspirating and dispensing operation of the syringes and detects the signals sent by the position sensor.

See figure 2-16 for details.

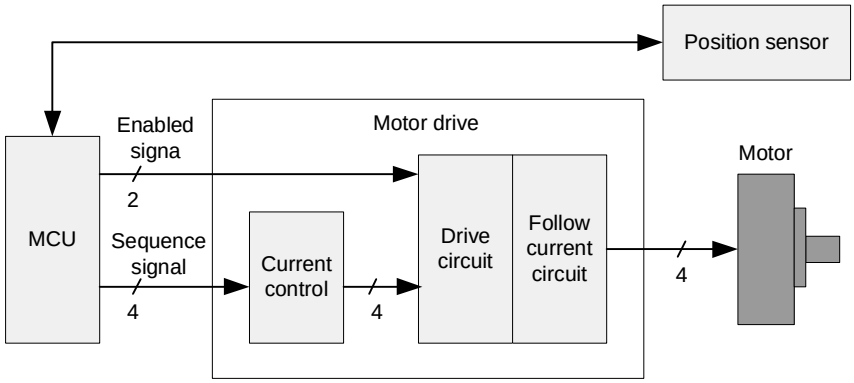


figure 2-16 Syringe motor control/drive

The MCU system provides control sequence signal for syringe motor, controls the device for motor position detecting and judges the motor positions through the feedback from the detecting device.

The drive circuit mainly consists of a L6506 (current control device), a L298N (drive device) and a UC3610 (follow current device). The drive voltage is 30V. The MCU I/O port provides ports for the sequence signal and driver enabled control.

n Drive/Signal-detecting Circuit of the Position Sensor

The control system judges the motor positions by the signals sent by the position sensor (photocoupler). The photocoupler is driven by the MCU through a 74LS07 and sends the position signals to the MCU through a 74LS14 (inverter). See the figure below for the position-detecting circuit. The photocoupler is installed on the sample probe assembly or syringe assembly and feeds the control and feedback signals to the drive board through cables.

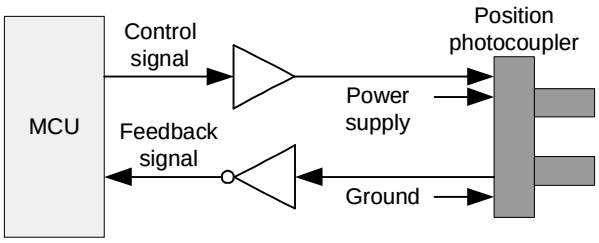


figure 2-17 Position-detecting circuit

Detectable Signal

Detection signals mainly consist of control signals for pumps/valves, sequence output signals for motor, detection signals for position sensor, serial signals, reset signals and signals for power supply voltage.

When the signal testing is on, connect the oscillograph and multimeter to DGND and PGND respectively.

Display Unit

Function of the LCD Adapter

The LCD adapter connects the LCD to the CPU board.

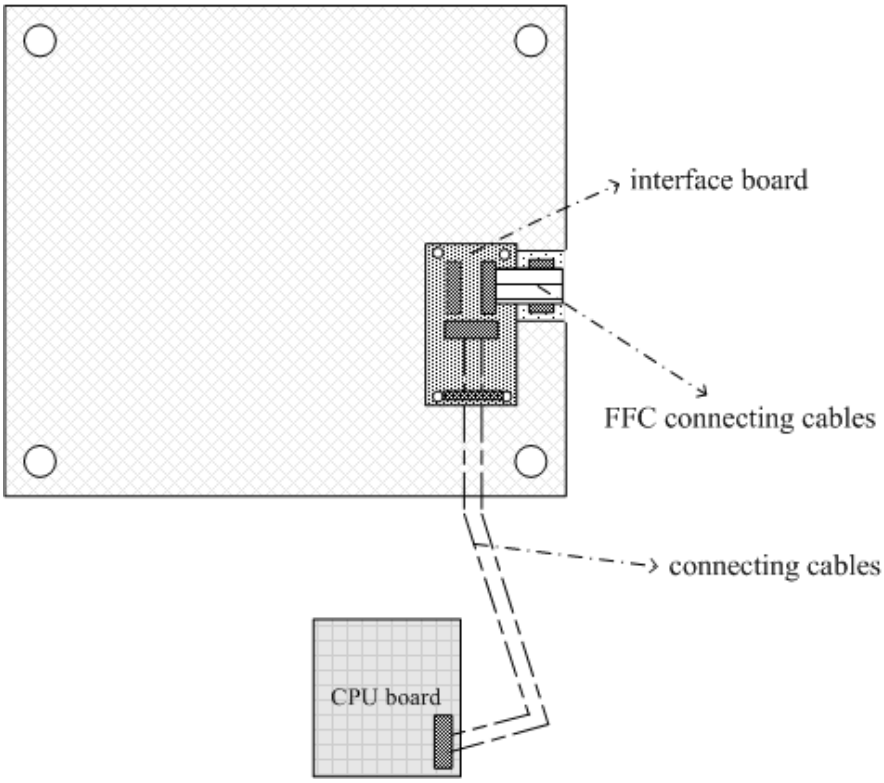


figure 2-18 Connection Schematic

Introduction of the LCD Adapter

The adapter incorporates two FPC/FFC connectors, J2 and J3. The J3 is for the BC-2300 display while the J2 is reserved for other Mindray analyzer. Only the J3 is installed for the BC-2300. The J1 serves to connect the LCD signal cable.

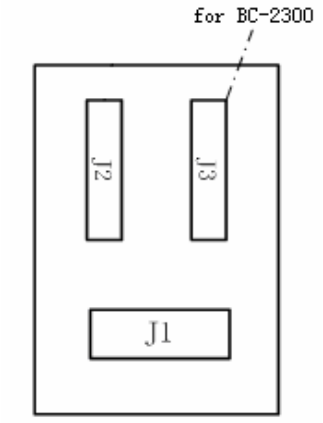


figure 2-19 Schematic of the adapter

Keypad Unit

Function of the Keypad Adapter

1. **To scan the keypad**

The keypad adapter scans the keypad and reports the scanned key code to the main board.

2. **To control the LCD brightness**

The keypad adapter receives the instructions from the main board to turn on/off the backlights and power indicator of the LCD and to control the brightness of the backlights.

3. **To control the buzzer**

The keypad adapter receives the instructions from the main board to turn on/off the buzzer.

Architecture of the Adapter

The adapter mainly consists of a MCU, keypad matrix, backlight control, power indicator control and buzzer.

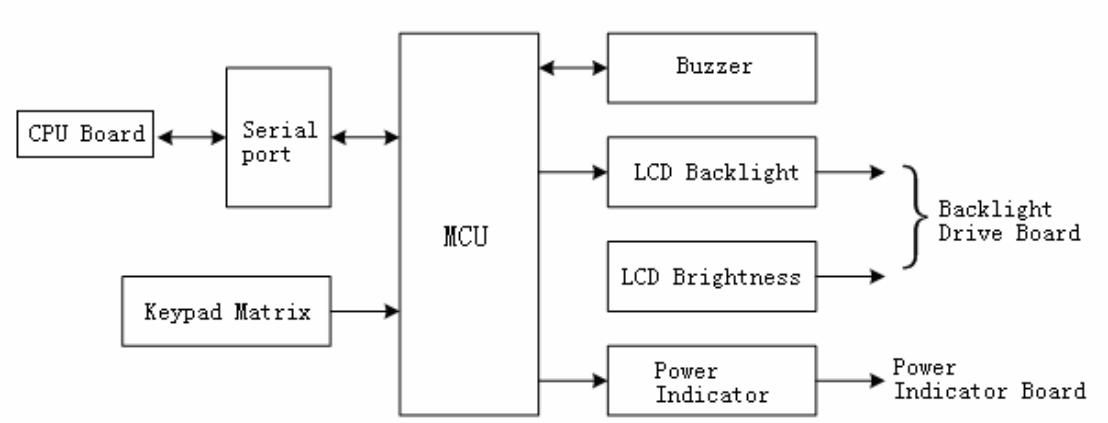


figure 2-20 Schematic of Keypad Adapter

Detailed Description

1. Power supply

The main board provides a +12V and 3.3V supplies, which are isolated from each other. The 3.3V supply is the main power of the adapter and the +12V is passed to the backlight board (inverter) of the LCD and also converted to a 5V supply to drive the buzzer and controls the on/off of the backlight power the adapter. Since the 3.3V and +12V are isolated, the MCU

send the control signals to the buzzer and backlight board through photocouplers.

2. MCU

The MCU is AT89C2051 whose resetting time is 470ms. It uses a 11.0592MHz crystal oscillator.

3. Keypad scanning

The keypad matrix is 5X4 one, incorporating 9 I/O wires and 20 keys. Note that the keys at line 5 and columns 3 and 4 are not used.

4. Backlight Control

The keypad adapter shuts off the backlight and blinks the power indicator when instructed by the main board to do so (usually after the analyzer entered the screen saver). The backlight board uses an independent 12V power supply and receives the control signals through photocouplers. The transistor is used to help control the LED so that the power indicator can be turned on even when something is wrong with the MCU.

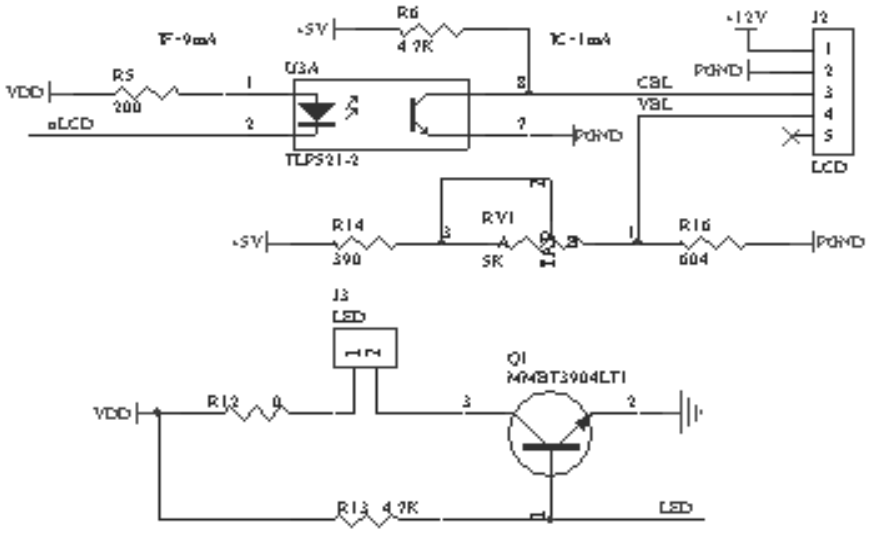


figure 2-21 Control of LCD brightness

The LCD brightness is controlled by pot RV1. Adjusting the RV1 can force the VBL to change within 0.5~3V. The voltage change is fed into the inverter and causes the change of the drive current and hence the change of the brightness. Note that the smaller the voltage and the brighter the LCD.

5. Buzzer Control

The buzzer is controlled by a DC signal (5V DC; current<40mA). The 5V supply of the

buzzer is isolated from the VDD and the control signal is received through a photocoupler （TLP521-2）that is controlled by a current around 10mA.

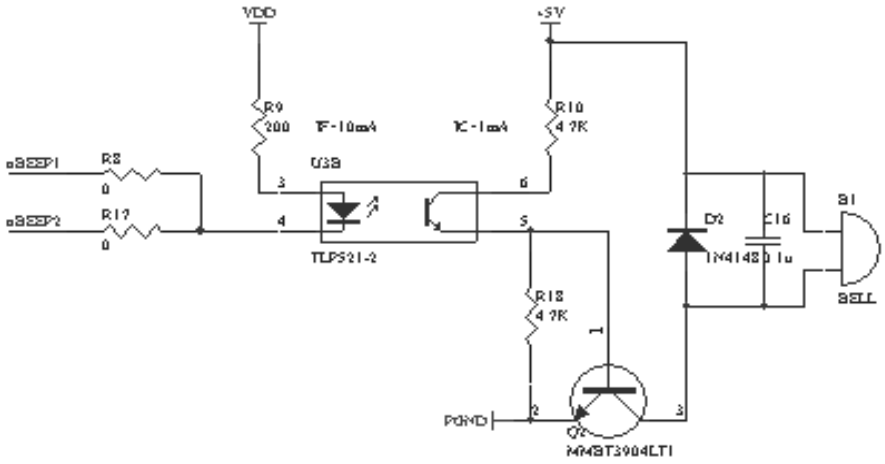


figure 2-22 Buzzer control

Analog Board

Analog board mainly has the following functions:

To convert the weak original output signals generated by each sensor into proper A/D signals.

To drive the sensors and realize the extraction, amplification, filter, limit, output buffer of the analog signals.

To monitor WRP signals, HGB signals, aperture voltage, vacuum/pressure and working voltage.

To control/drive the aperture zapping.

Analog Board and Functions for Each Module

Analog board circuit, as shown in the figure below, consists of power supply unit, volumetric signal adjustment unit, HGB signal adjustment unit, vacuum/pressure signal adjustment unit, monitor unit and interface unit.

Basic functions:

- **Power supply unit:** to provide various operating power supply and drive current for the analog board.
- **Volumetric signal adjustment unit:** to convert the weak original output signals generated by each sensor into proper A/D input signals.
- **HGB signals adjustment unit:** to convert the output signals generated by HGB sensor into proper A/D input signals.
- **Vacuum/pressure signals adjustment unit:** to convert the output signals generated by vacuum/pressure sensors into proper A/D input signals.
- **Monitor unit:** to monitor operating voltage and the volumetric signals sensor.
- **Interface unit:** to realize the interface of analog board and CPU board.

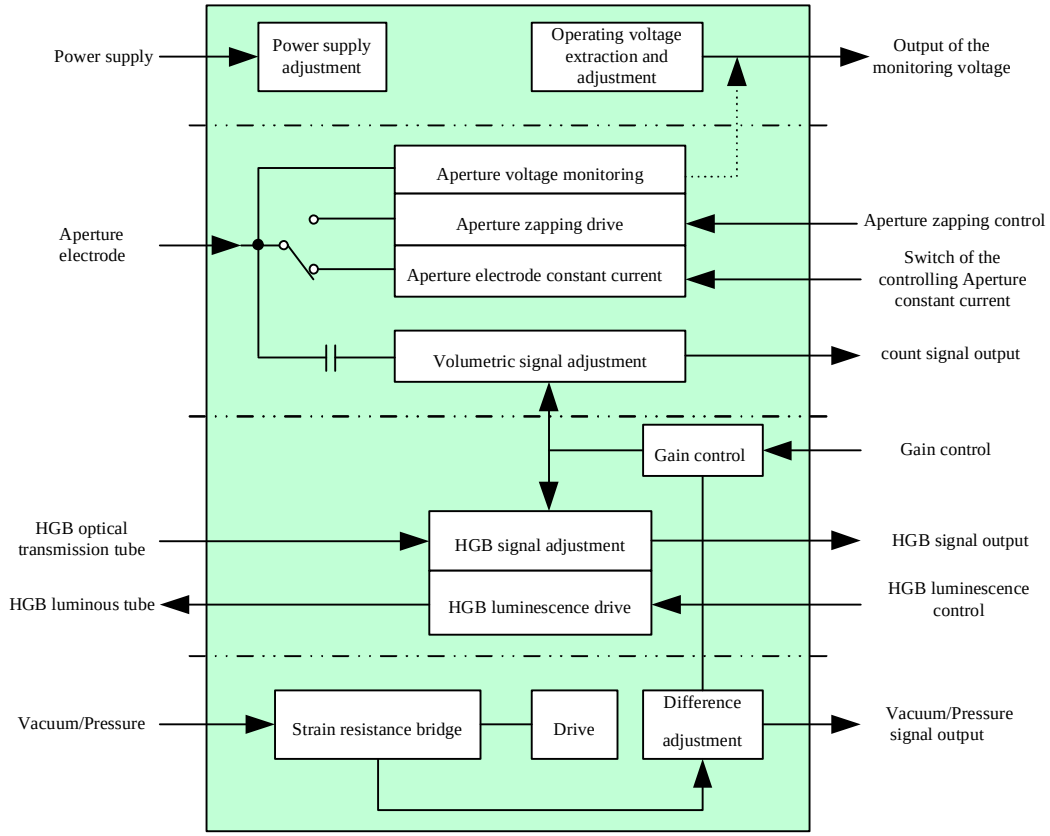


figure 2-23 Analog board circuit

Module Circuits

2.6.2.1 Power Supply Circuit

Analog board mainly applies +5VA, ±12VA, +56VA and +100VA DC power supply. ±12V is derived from switching power supply board. The normal working voltage of test points TP1 is -12V, and TP2 is +12V, -12V and +12V are obtained after being filtered. +5V power supply is derived from +12VA voltage adjustment, and the voltage of TP4 is +5V.

As the power supply and the stabilized voltage supply for +56V, +100V is derived from +12VA power supply by DC-DC. The voltage of TP3 is +100V.

2.6.2.2 Monitor Unit

The monitor unit monitors the conversion from ±12VA and +56VA DC power supply voltage to 3V±3% and 2.2±3% respectively by the voltage rated value.

As part of the volumetric signal unit, the change-over circuit monitors the volumetric signal sensor and provides the changed signal. In monitor unit, the change-over circuit only provides the output circuit.

TP5, TP6 and TP7 monitor the power supply of +12VA、-12VA and +56VA respectively.

The rated voltages of the three test points are 3V±3%, 3V±3% and 2.2±3% respectively.

TP8 monitors the volumetric signal sensor. The output voltage of TP8 is about 3.4V, when the voltage of the aperture sensor electrode is +12V.

2.6.2.3 Interface Unit Circuit

The interface unit mainly isolates/converts the digital control signal of the main board.

n Digital Pot Control Interface

3 pots (with 1 unused) output controls the gain adjustment of the volumetric signal unit and HGB unit circuit.

n On-Off Control Signal Interface

On-off control interface isolates/drives the control signal of CPU board.

2.6.2.4 Volumetric Signal Adjustment Unit

Volumetric signal adjustment unit mainly consists of electrode drive circuit, amplifier filter circuit and output clamper circuit.

n Constant-Current Source Circuit

Constant-current source circuit consists of the constant-current source circuit for sensors and the zapping circuit whose on-off is controlled by the CPU control signals.

n Amplifier Filter Circuit

Amplifier filter circuit mainly amplifies, filters and then adjusts the input signals to output proper A/D signals. See the following figure for details.

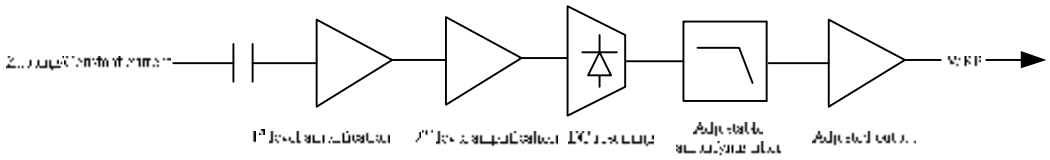


figure 2-24 Volumetric signal unit

n Output Clamper Circuit

Clamper circuit is applied to the volumetric signal output port to limit the voltage of output signals within -0.3V-5.2V. TP10 is the test point of volumetric signal output. The voltage of TP10 should be proper for clamper circuit output.

2.6.2.5 HGB Signal Adjustment Unit

HGB signal adjustment unit provides drive current for the HGB sensor and converts the output signals of the sensor into proper A/D signals. The circuit consists of constant current drive and signal adjustment, as shown in the figure below.

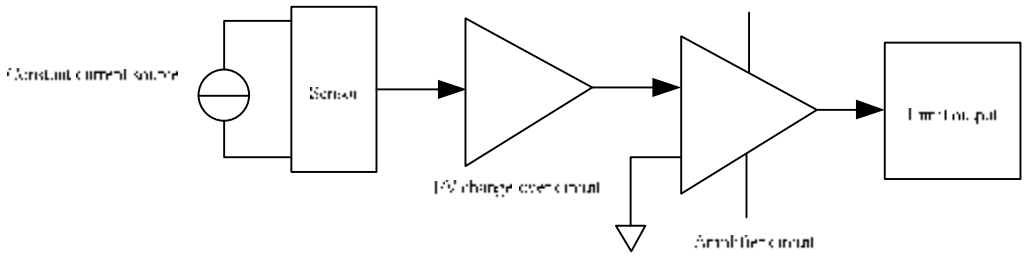


figure 2-25 HGB signal adjustment unit

2.6.2.6 Vacuum/Pressure Signal Adjustment Unit

Vacuum/Pressure signal adjustment unit measures the real-time pressure of the vacuum/pressure chamber. The analog board uses only 1 channel vacuum/pressure detection and output. See the figure below for details.

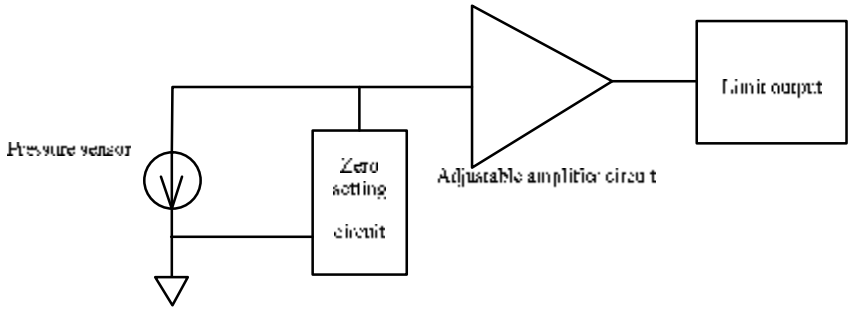


figure 2-26 Vacuum/Pressure measuring unit

The pressure sensor is driven by ZR431F (the constant current source). The out-of balance adjustment is realized by 200Ω pot.

In the maintenance checking, the voltage of both TP14 and TP15 is about 2.5V, and the error is within 0.05V. Adjust the pot VR1 (zero pot) to make the voltage of TP17 (vacuum/pressure detection output) 2.5V. Adjust the gain pot VR4 to make the voltage of TP17 4.5V when the detection pressure of the sensor is +25kPa, and 0.5V when -25kPa. Vacuometer is used when the circuit gain calibration is adjusted.

Analog Board Pot and the Adjustment Method

The adjustment pot is needed only in the vacuum/pressure measuring circuit on the analog board. See the vacuum/pressure signal adjustment unit for details.

Test Points

See the figure below for the test point information

Table 2-1 Test points

Test Point	Description	Voltage Range
TP1	AVSS power supply test point	-12±1V
TP2	AVCC power supply test point	+12±1V
TP3	+100V test point	+100±5V
TP4	+5V DC power supply	+5±0.25V
TP5	AVCC-MON voltage monitoring point	3±3% V
TP6	AVSS-MON voltage monitoring point	3±3% V
TP7	+56VA-MON voltage monitoring point	2.2±3% V
TP8	WRBC-H aperture voltage monitoring point	0~5V
TP10	Output of the WRP amplifying channel	0~5V
TP11	HGBIN consistent current test point	0~5V
TP13	HGB detection circuit test point	0~5V
TP14	Output of the 2.5V voltage adjustment	2.5±0.05V
TP15	Detection of the consistent current for the vacuum pressure unit	2.5±0.05V
TP16	Output of the pressure measuring circuit	0~5V
TP17	Output of the vacuum measuring circuit	0~5V

3 Disassembling/Replacing Parts and Components

System Structure

User Interfaces

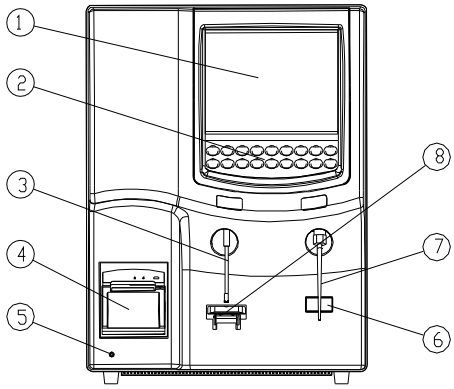


figure 3-1Front view

1 ---- LCD

2 ---- Keypad

3 ---- Sample suction nozzle

4 ---- Recorder

5 ---- Power indicator

6 ---- Diluent key

7 ---- Diluent dispenser

8 ---- Sample cup stand

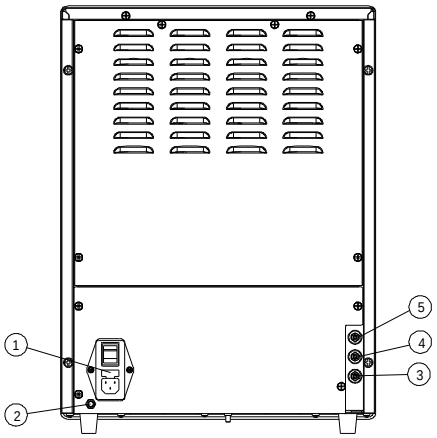


figure 3-2Back view

1 --- Disaster box

2 --- Equipotentiality

3 --- Waste outlet（red）

4 --- Lyse inlet（orange）

5 --- Rinse inlet（green）

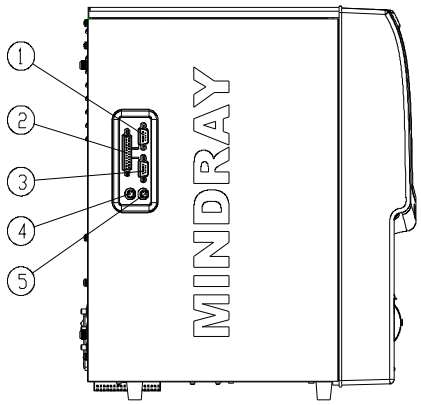


figure 3-3Left view

1 --- RS-232 Port1,connect to the bar-code scanner and floppy drive

2 --- Parallel Port, connect to the printer

3 --- RS-232 Port2, connect to the external computer

4 --- Power Interface of Floppy Disk Drive

5 --- Keyboard interface

Disassembling Main Unit

NOTE

- **Unless otherwise instructed, always turn off the power before trying to assemble/disassemble your analyzer or fix the error.**
- **All the analyzer components and surfaces are potentially infectious, take proper protective measures for operation or maintenance.**

Removing the Left/Right Board and Top Cover

As shown in the figure，remove screws (2 screws for each board), indicated by dash line, with cross screwdriver to remove each board.

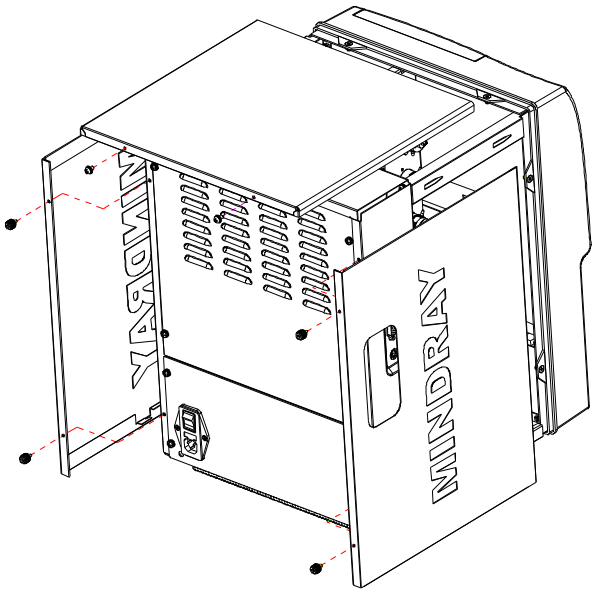


figure 3-4 Remove of left/right board and top cover

Removing the Back Cover & Power Supply Assembly

As shown in the figure，remove screws (totally 10 screws), indicated by the dash line, with cross screwdriver to remove the back cover and power supply assembly.

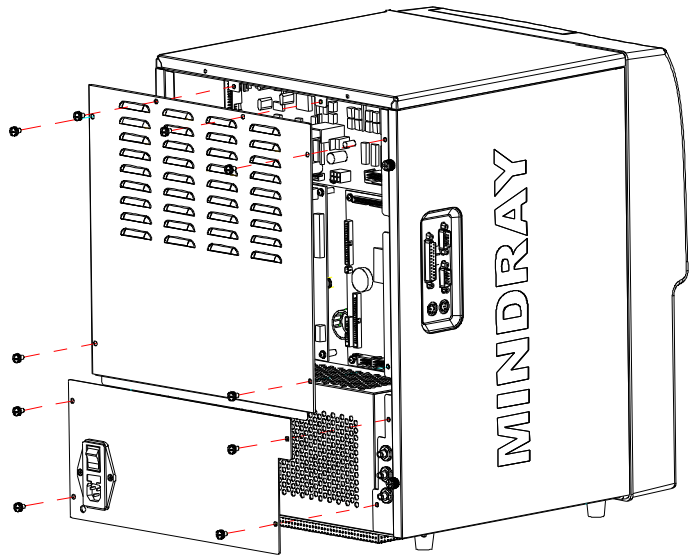


figure 3-5 Remove of back cover and power supply assembly

Removing the Front Panel Assembly

As shown in the figure, remove the glass tube ring securing the diluent dispenser and then remove the screws (totally 6 screws), indicated by the dash line, with cross screwdriver to remove the assembly.

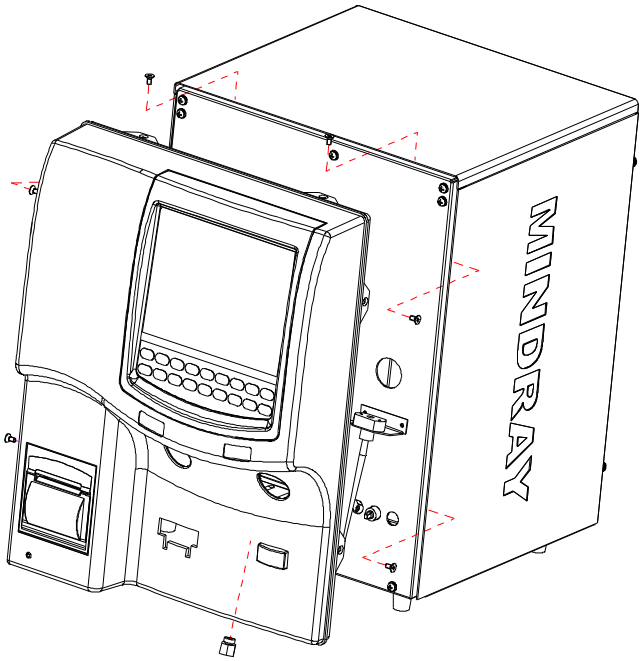


figure 3-6 Remove of the front panel assembly

Removing the LCD Assembly

As shown in the figure, remove screws (totally 4 screws), indicated by the dash line, with cross screwdriver to remove the screen.

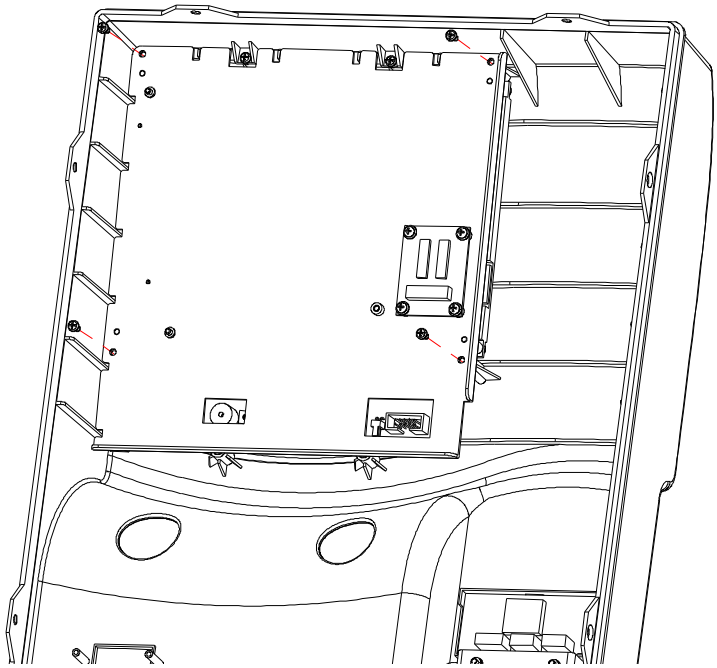


figure 3-7 Remove of LCD assembly

Removing the Keypad

As shown in the figure, remove screws (totally 7 screws), indicated by the dash line, with cross screwdriver to remove the keypad.

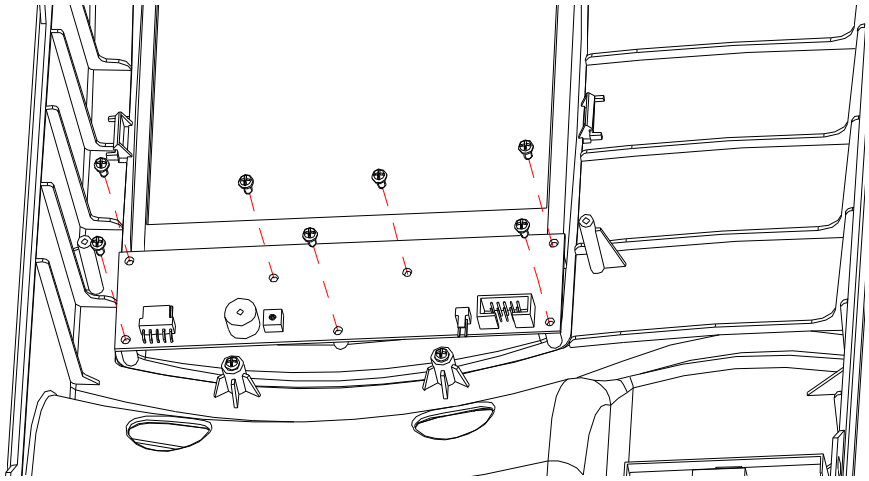


figure 3-8Remove of the keypad

Removing the LCD and the Converter Board

As shown in the figure, remove screws (totally 8 screws), indicated by the dash line, with cross screwdriver to remove the LCD and the converter board.

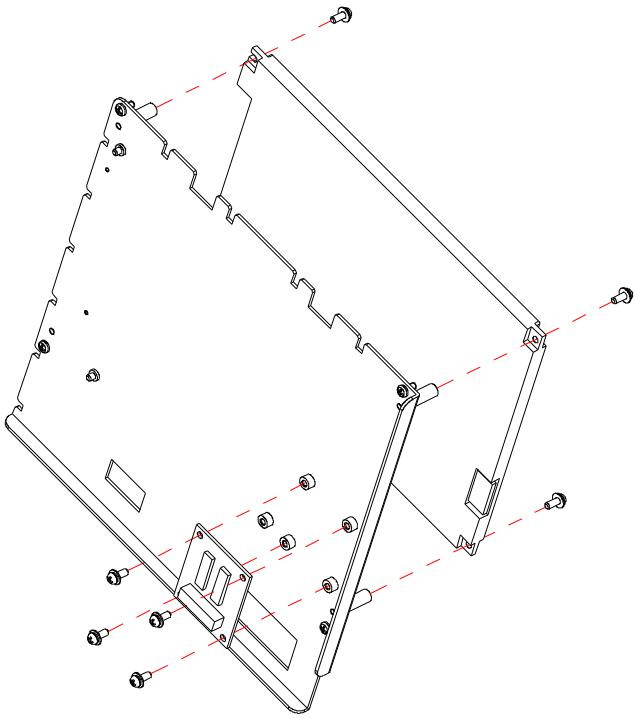


figure 3-9 Remove of the LCD and the converter board

Removing the Power Supply Shielding Box

As shown in the figure, remove screws (totally 3 screws), indicated by the dash line, with cross screwdriver to remove the power supply shielding box.

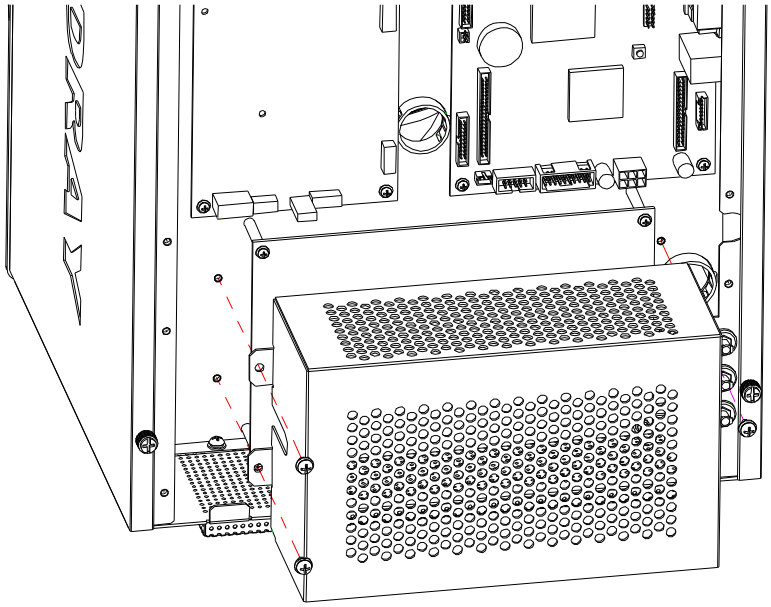


figure 3-10 Remove of the power supply shielding box

Removing the main Bords

As shown in the figure, remove the screws (totally 18 screws), indicated by the dash line, with the cross screwdriver to remove the Power Board, Analog Board, CPU Board and Power Supply Board.

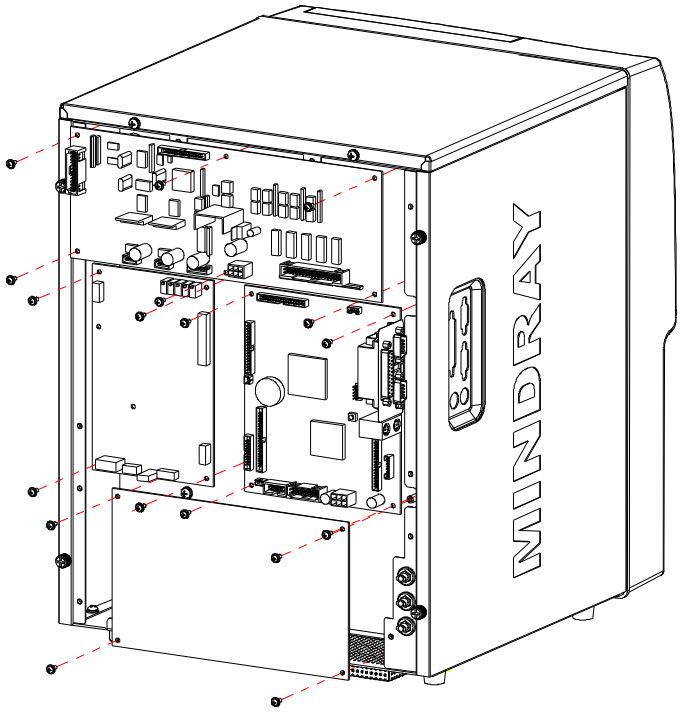


figure 3-11 Remove of the main boards

Removing the Pump and Pump Assembly

As shown in the figure, remove the screws (totally 8 screws), indicated by the dash line, with the cross screwdriver to remove the pump and the assembly.

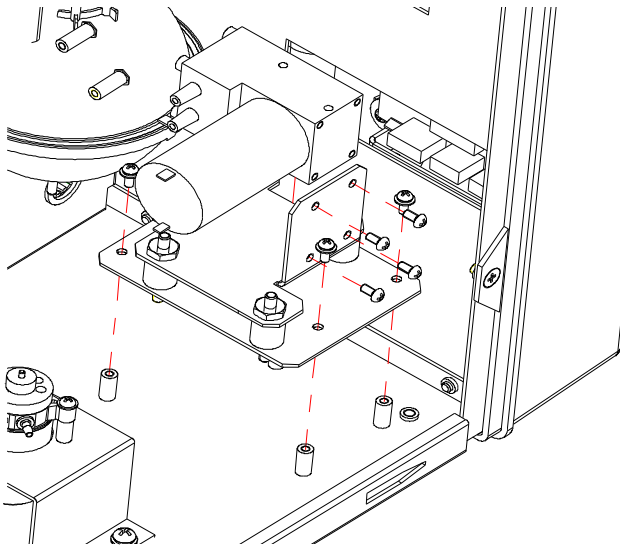


figure 3-12Remove of the pump and pump assembly

Removing the Valves

As shown in the figure, remove the screws (2 screws for each valve), indicated by the dash line, with the cross screwdriver to remove the valves.

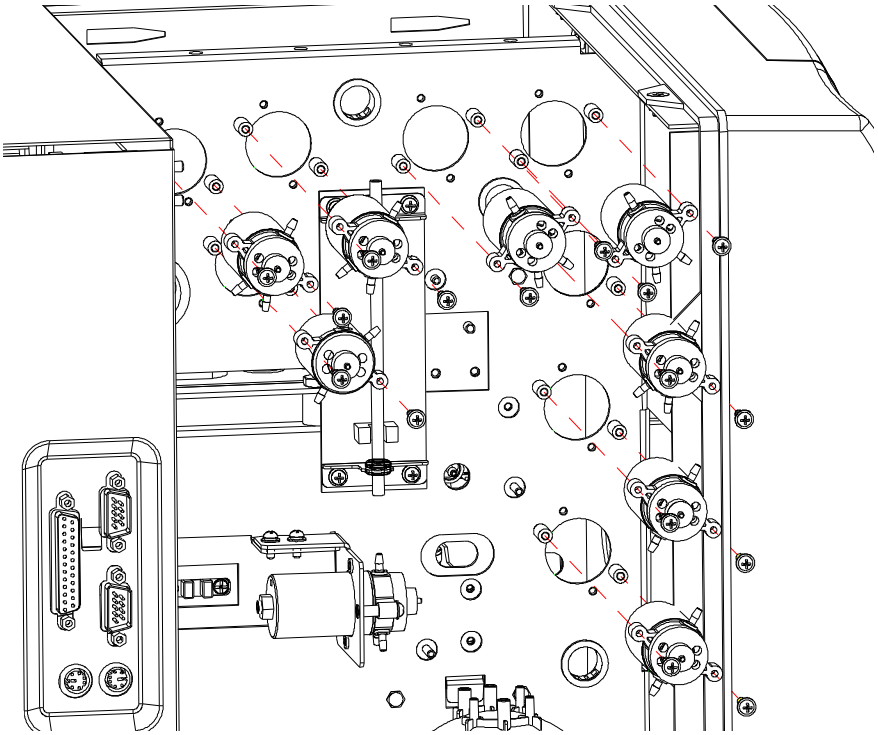


figure 3-13 Remove of the valves

Removing the Valve 6

As shown in the figure, remove the screws (totally 2 screws) securing the valve assembly bracket, remove the assembly, and then remove the screws (totally 2 screws) securing the valve with cross screwdriver to remove the valve 6.

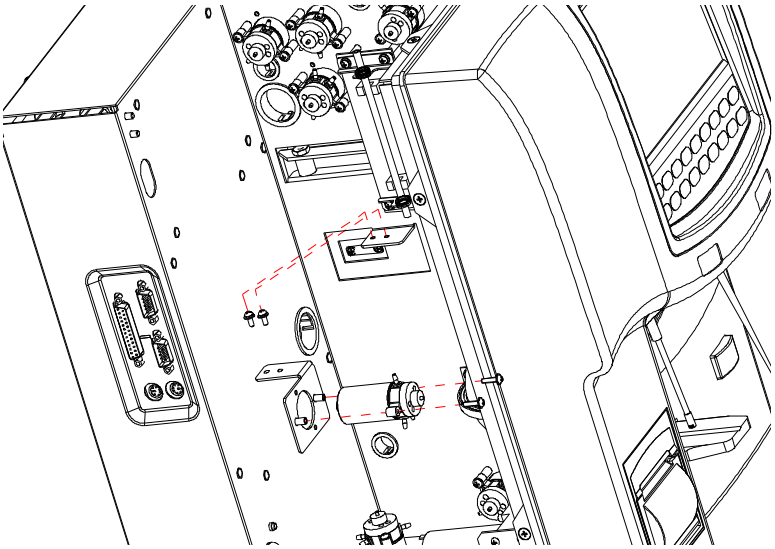


figure 3-14 Remove of the valve 6

Removing the Syringe Assembly

As shown in the figure, remove the screws (totally 4 screws), indicated by the dash line, with cross screwdriver to remove the syringe assembly.

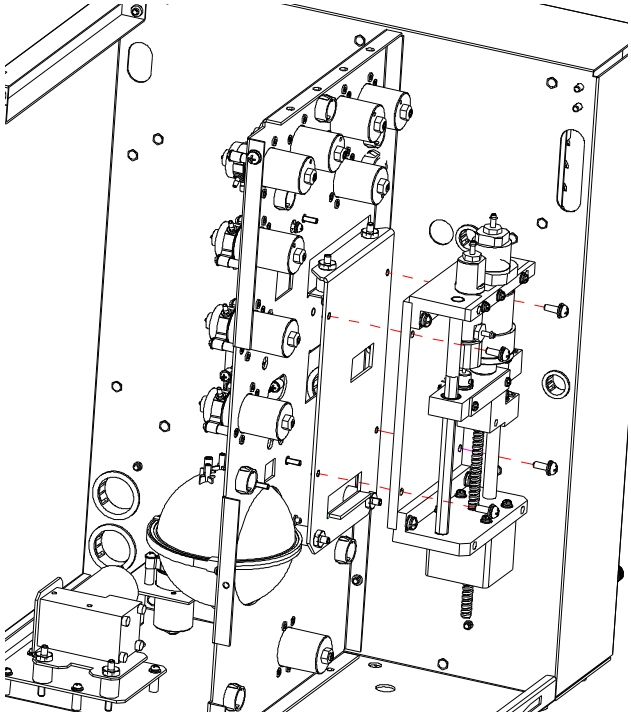


figure 3-15 Remove of the syringe assembly

Removing the Volumetric Unit

As shown in the figure, remove the screws (totally 4 screws), indicated by the dash line, with cross screwdriver to remove the volumetric unit.

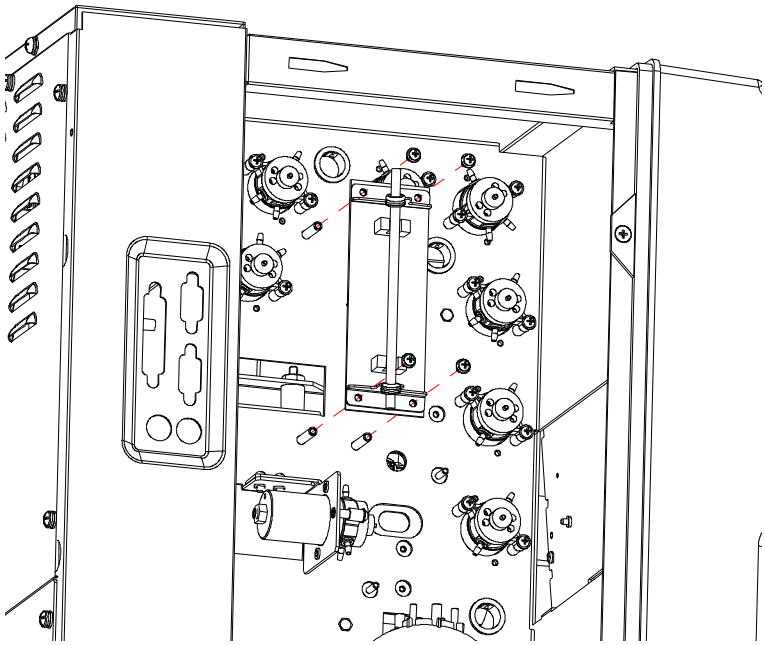


figure 3-16 Remove of the volumetric unit

Removing the Vacuum Assembly

As shown in the figure, remove the screws (totally 2 screws), indicated by the dash line, with cross screwdriver to remove the vacuum assembly.

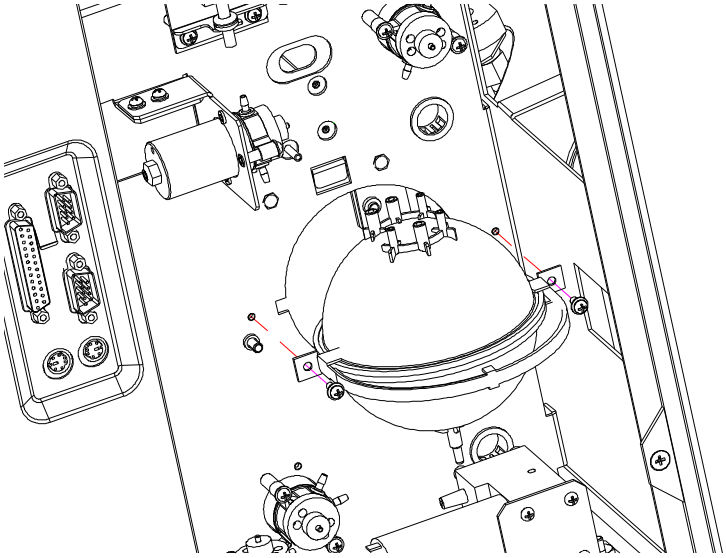
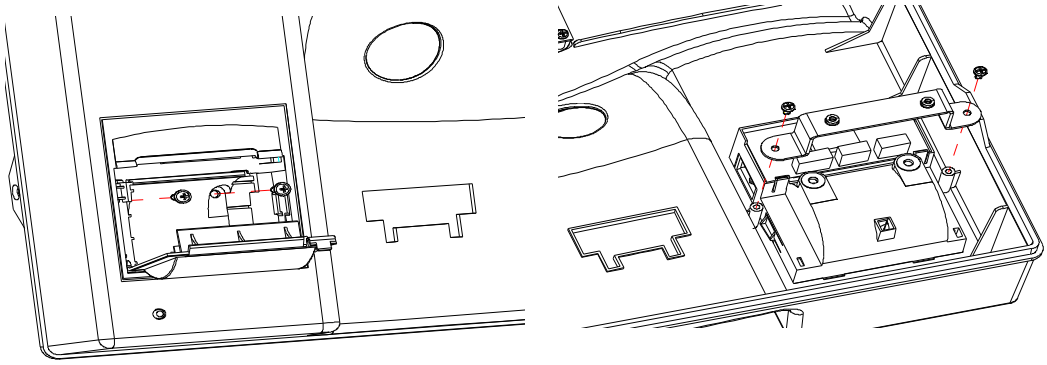


figure 3-17 Remove of the vacuum assembly

Removing the Recorder

As shown in the figure, open the door of the recorder and remove the screws (totally 2 screws), indicated in figure A and then the 2 screws in figure B, to remove the recorder.



A B

figure 3-18Remove of the recorder

Removing the Converter Assembly

As shown in the figure, remove the 2 screws securing the converter shielding box and the 2 screws securing the converter to remove the converter assembly.

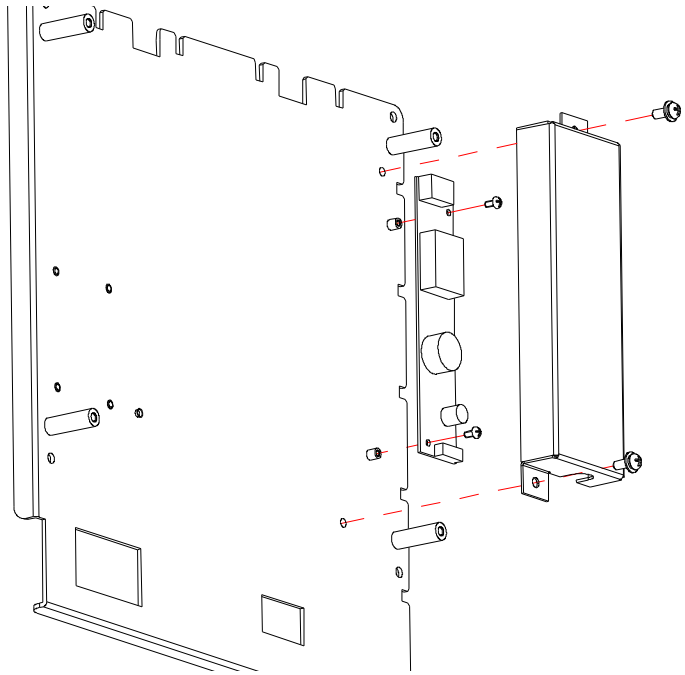


figure 3-19 Remove of the converter assembly

4 Fluidic System

Fluidic System

1. Preparing diluent for the whole blood mode and predilute mode
2. Counting the blood cells and measuring the HGB concentration
3. Dispensing the diluent precisely
4. Flushing and cleaning automatically
5. Controlling the pressure and vacuum

Construction of Fluidic System

The fluidic system mainly has three parts: the syringe assembly, pump assembly and volumetric metering unit.

- **n** Syringe assembly
- **n** Pump assembly
- **n** Volumetric metering unit

See **Chapter 3 Disassembling/Replacing Parts and Components** for the construction.

Composition of Fluidic System

The fluidic system consists of the following subsystems: sensor subsystem, bath subsystem, lyse dispensing and mixing subsystem, diluting subsystem, volumetric metering subsystem, vacuum subsystem, pressure subsystem and auxiliary subsystem.

The key components of the fluidic system are the solenoid valve, syringe, aperture, sample suction nozzle, diluent dispenser, isolated chamber, pump, bath, metering tube, negative/positive chamber and tube.

Where, solenoid valves are made by Mindray. Totally 10 valves are used, with 8 three-way valves and 2 two-way valves.

Two syringes, 7.5mL and 50μL, are made by Mindray.

The aperture is Ø80um.

The sample suction nozzle uses the Teflon (FEP) tube. The sample suction nozzle is enveloped by the steel tube. At the bottom of the tube is a filter, to prevent clogging.

Functional Modules

The fluidic system can be divided into the following functional modules: aspiration/

dispensing module, counting module, washing module, hydraulic module, mixing module and waste discharging module. See the figure below for the interaction of these modules.

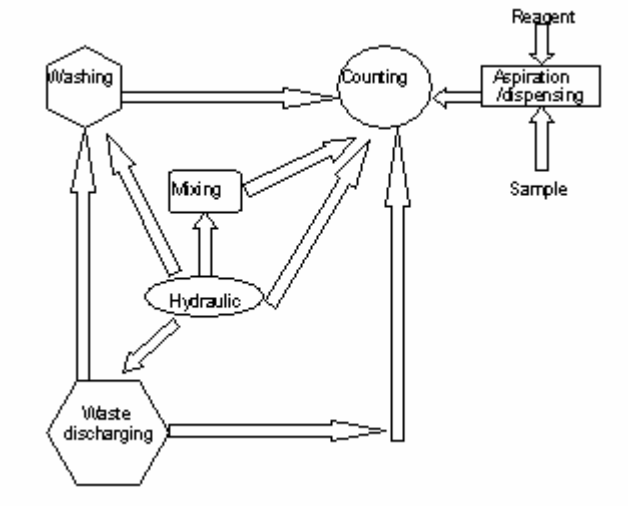


figure 4-1 Interaction of the functional modules

Aspiration/Dispensing Module

The aspiration/dispensing module includes a motor that drives the 50μL and 7.5mL syringes. 50μL syringe aspirates/dispenses the whole blood sample and the sample for RBC counting. 7.5mL syringe aspirates/dispenses the sample for WBC counting, diluent and lyse. See the figure below for details.

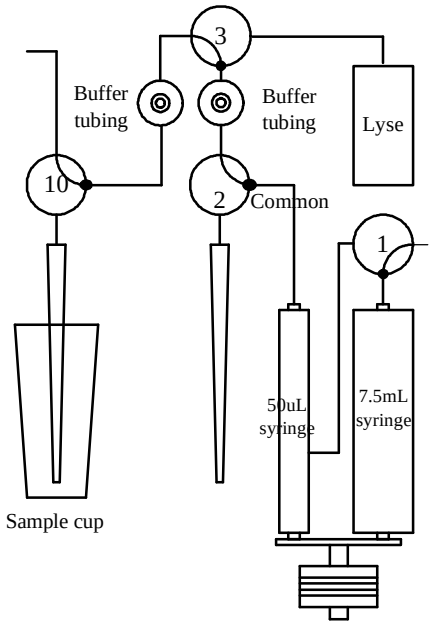


figure 4-2 Aspiration/Dispensing module

The RBC sample is aspirated and dispensed into the bath as described below:

Valve 10 is opened and the motor pulls the 50μL syringe plunger downward to aspirate a certain amount of sample for RBC counting which is stored in the sample suction nozzle into

the common tubing connecting to valve 10. Valve 10 is closed later and the 7.5mL syringe keeps moving down to aspirate a certain amount of diluent. Then valve 1 is opened and the motor runs reversely to push the syringe plunger upward to dispense the diluent and sample for RBC counting into the bath.

The WBC sample and lyse are aspirated and dispensed into the bath as described below:

Valves 1 and 10 are opened and the motor pulls the 7.5mL syringe downward to aspirate a certain amount of sample into the buffer tubing between valve 3 and valve 10. Valve 10 is closed and valve 3 is opened later. The 7.5ml syringe keeps moving down to aspirate a certain amount of lyse into the buffer tubing between valve 2 and valve 3. Then valve1 and valve 3 are closed and the syringe moves down to aspirate a certain amount of diluent. Valve 1 is then opened and the motor runs reversely to push the syringe plunger upward to dispense the stored lyse and sample for WBC counting into the bath.

Since the capacity of the buffer tubing is far greater than the volume of the aspirated lyse, the lyse will not overflow to the syringe through valve 2 and the sample will not overflow to the buffer tubing of the lyse through valve 3.

Note that the length and type of the buffer tubing shall not be changed in the maintenance.

Counting Module

As shown in the figure below, the counting module consists of bath, valves 6 and 7, filter, volumetric metering tube, negative chamber and other supporting components.

The counting module implements the most important function of the analyzer - counting. The electrodes installed on the bath detect the pulses caused by blood cells passing the aperture. The detected pulses are then sent to the analog board to be amplified, rectified, recognized, adjusted and counted.

When the sample is mixed in the bath, valve 6 is open after the vacuum has been established and the sample (blood cells) in the bath is drawn through the aperture by the negative pressure to generate the counting pulses. The sample keeps moving to push the rinse between the back bath and metering tube to move through the tube. When the rinse passes the lower optical sensor mounted on the metering tube, a start signal is generated and sent to the analog board, which starts the counting right away, and when the rinse passes the upper optical sensor, a stop signal is generated and sent to the analog board, which stops the counting right away.

Volumetric metering: the volumetric metering ensures a relatively objective and stable

analysis cycle.

Monitoring of the counting time: the volumetric metering enables the monitoring of the counting time. By monitoring the counting time, the system can easily know whether the aperture is clean or clogged and feed this information to the service personnel in terms of the aperture voltage so that they can service the analyzer in time.

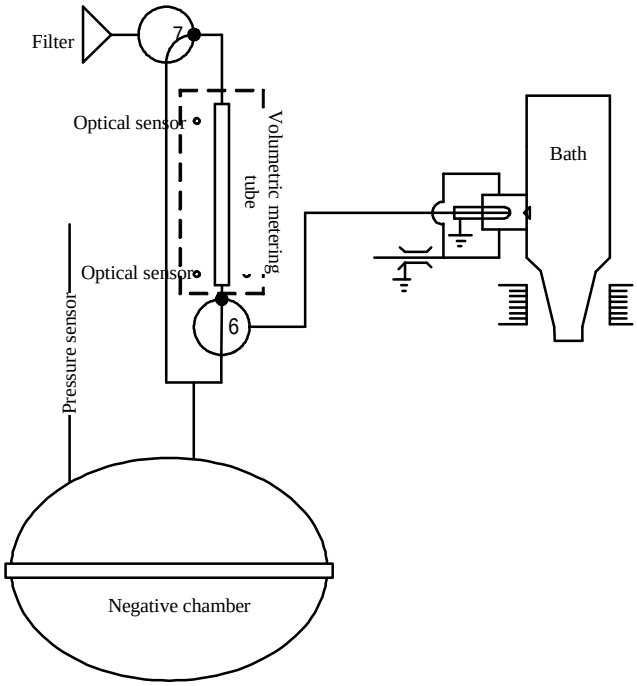


figure 4-3 Counting module

Washing Module

The flushing module includes: washing the front and back bath; flushing the aperture and flushing the fluidic lines.

The part that washes the baths is shown in the figure below. The front bath is washed first and the back bath is washed later.

To wash the front bath: after vacuum is established, with the opened and closed of valve 5, diluent in the front bath is displaced. During the displacement, the front bath is washed.

To wash the back bath: after vacuum is established, valve 4 and valve 6 are opened at the same time so that the back bath and metering tube are flushed quickly.

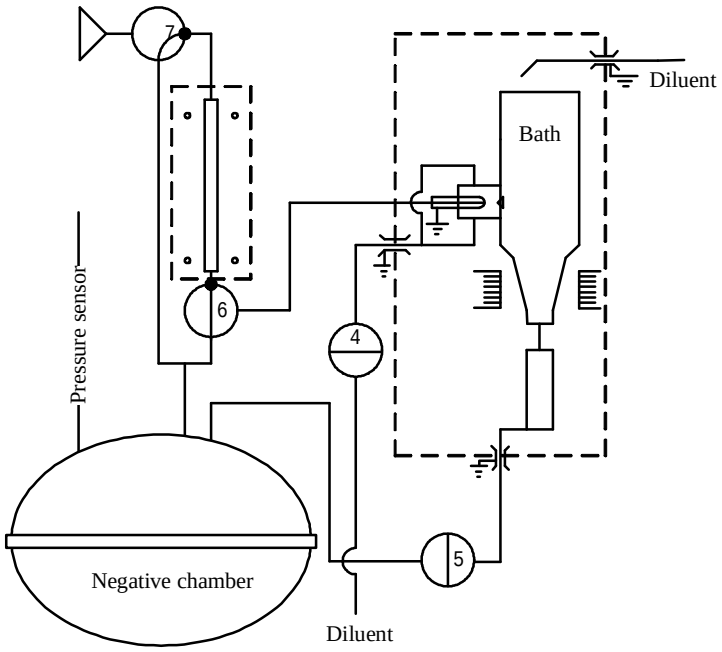


figure 4-4　Washing module of fluidic system（washing of front and back baths）

Hydraulic Module

Figure below shows the hydraulic module. This module serves to establish the negative pressure and the positive pressure.

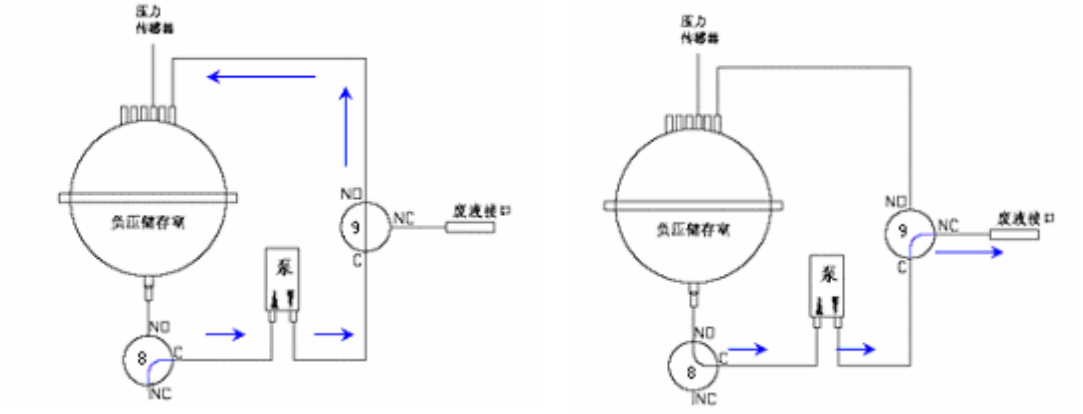


figure 4-5　Hydraulic module (the left establishes the pressure; the right establishes the vacuum)

To establish positive pressure: when both valve 8 and the pump are opened, the pump aspirates atmospheric air through the NC end of valve 8. The air is stored in the pressure chamber to establish positive pressure. The pressure value, pump and valve are monitored by the pressure sensor.

To establish negative pressure: when both valve 9 and the pump are opened, the liquid and air in the pressure chamber are discharged through the path of the NO end of valve 8, the pump and the NC end of valve 9. At the same time, the vacuum is established and the pressure value is monitored by the pressure sensor.

The pump is an imported American product.

Mixing Module

Bubble mixing method is applied here. As shown in the figure below, the aspirated sample needs to be diluted before the counting. Once the sample is dispensed into the bath containing a certain amount of dilute, the system will inform the mixing module to work. Then the positive pressure is established inside the pressure chamber. Then the brief on/off of the valve separates the air in the pressure chamber into several air segments and expels them into the bath to introduce bubbles. The bubbles pop up from the bottom of the bath and the mixing is done thus.

The on/off interval of the valve is critical to the effect of the bubble mixing. Either too many or too few bubbles will affect the mixing. During the mixing process, the airway should be well drained, or the trapped liquid will affect the quantity of the bubbles as well as the dilution.

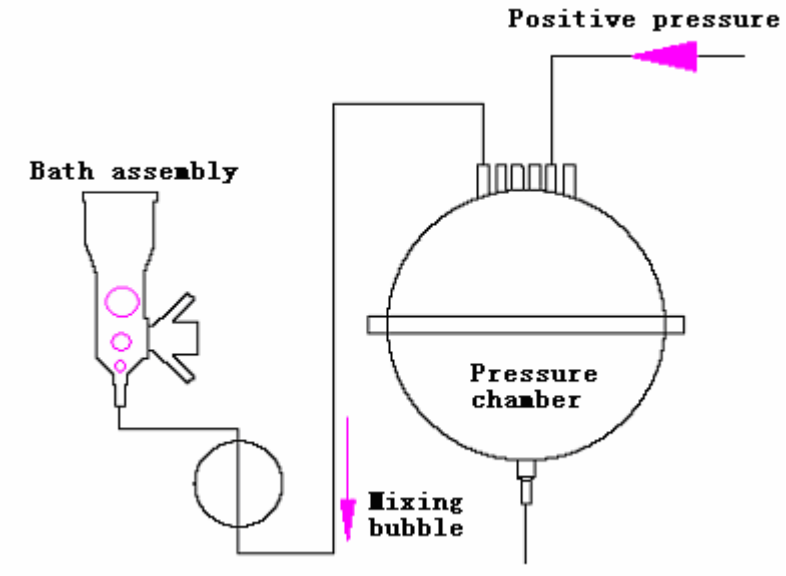


figure 4-6 Mixing module

Waste Discharging Module

The waste discharging includes: discharging the waste of the bath; discharging the

waste of pressure chamber. As shown in the figure below, once the negative pressure is established inside the pressure chamber, valves 5 and 9 will open to discharge the waste of the bath to the outside through the pressure chamber and the pump.

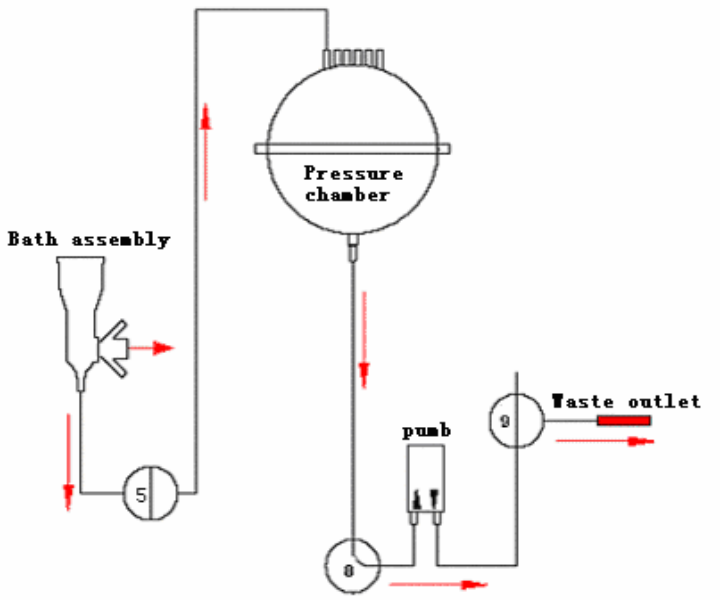


figure 4-7 Waste discharging module

Counting Timing

Usually in blood samples, the cells are too close to each other to be identified or measured. For this reason, the diluent is used to separate the cells so that they are drawn through the aperture one at a time as well as to create a conductive environment for blood analysis. This analyzer can process two types of blood samples – whole blood samples and prediluted blood samples.

Whole Blood Mode

To analyze a whole blood sample, the operator can simply present the sample to the diluent dispenser and press the Diluent key to aspirate 20μL of the sample into the dispenser. A diluted sample (about 1:300) will be dispensed when Diluent key is pressed the again. Mix the sample thoroughly and present the well-mixed diluted sample under the sample suction nozzle and press the [COUNT] key to aspirate sample into the analyzer.

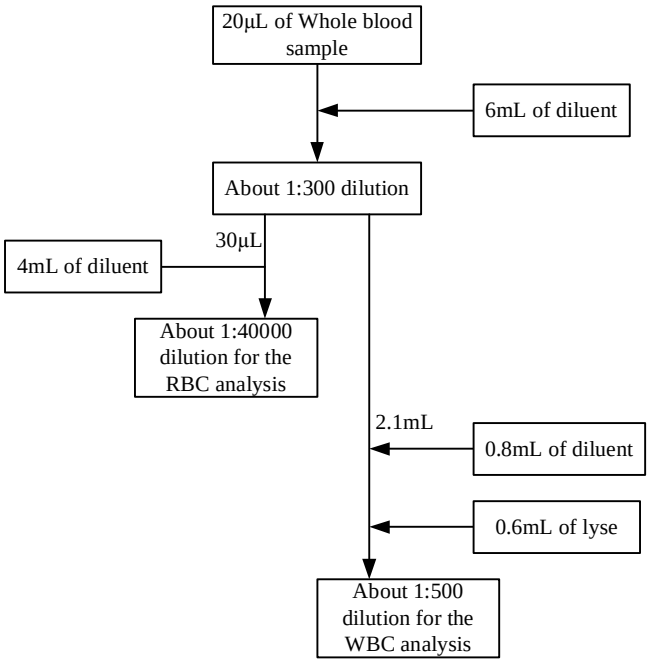


figure 4-8 Diluting procedure of whole blood mode

Predilute Mode

To analyze a capillary blood sample, the operator should first manually dilute the sample (20μL of capillary sample needs to be diluted by 6mL of diluent) and then present the pre-diluted sample to the sample suction nozzle and press the [COUNT] key to aspirate the sample into the analyzer.

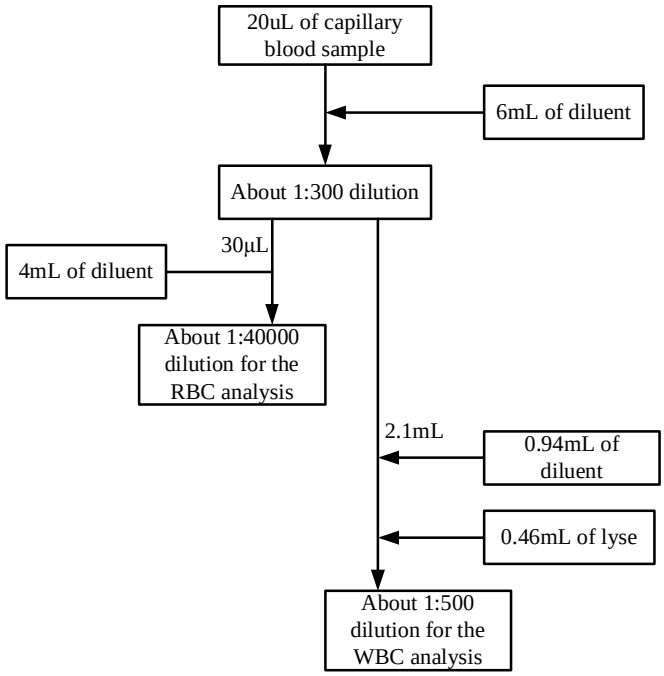


figure 4-9 Diluting procedure of predilute mode

Volume Range of Blood Cells

After reacting with the diluent and lyse, the cell volumes mainly fall into the following ranges:

WBC: 30-350fL
RBC: 25-250fL
PLT: 2-30fL

5 Software

Executing of the Bootstrap Program

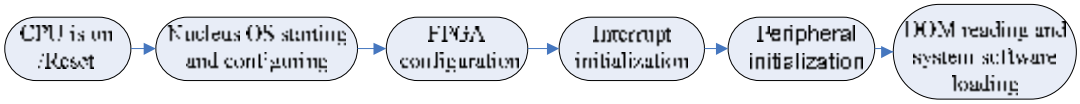


figure 5-1 Executing of the bootstrap program

1. Initializing the Nucleus OS: to establish the task and timer required by system software and set them at the initialization state.
2. Configuring the FPGA: to write the FPGA configuration data into the FPGA.
3. Initializing the peripheral: to initialize 6 serial ports, Super I/O and the I^2C bus line.
4. Loading the system software: to copy the system software in the DOM to the designated memory and execute the software there.
5. For the convenience of designing, the bootstrap program is only displayed in English in the center of the screen.

(1) “initializing” is displayed when the FPGA has configured.

(2) As shown in the figure below, the second point is displayed when the IDE DOM has been found.

figure 5-2 Bootstrap software display

(3) After the system software in the DOM has been read, “initializing” is displayed, which indicates the successful load of the system software, the end of the bootstrap and the beginning of the loaded system software.

System Software Initialization

The flow chart of system software initialization is as follows.

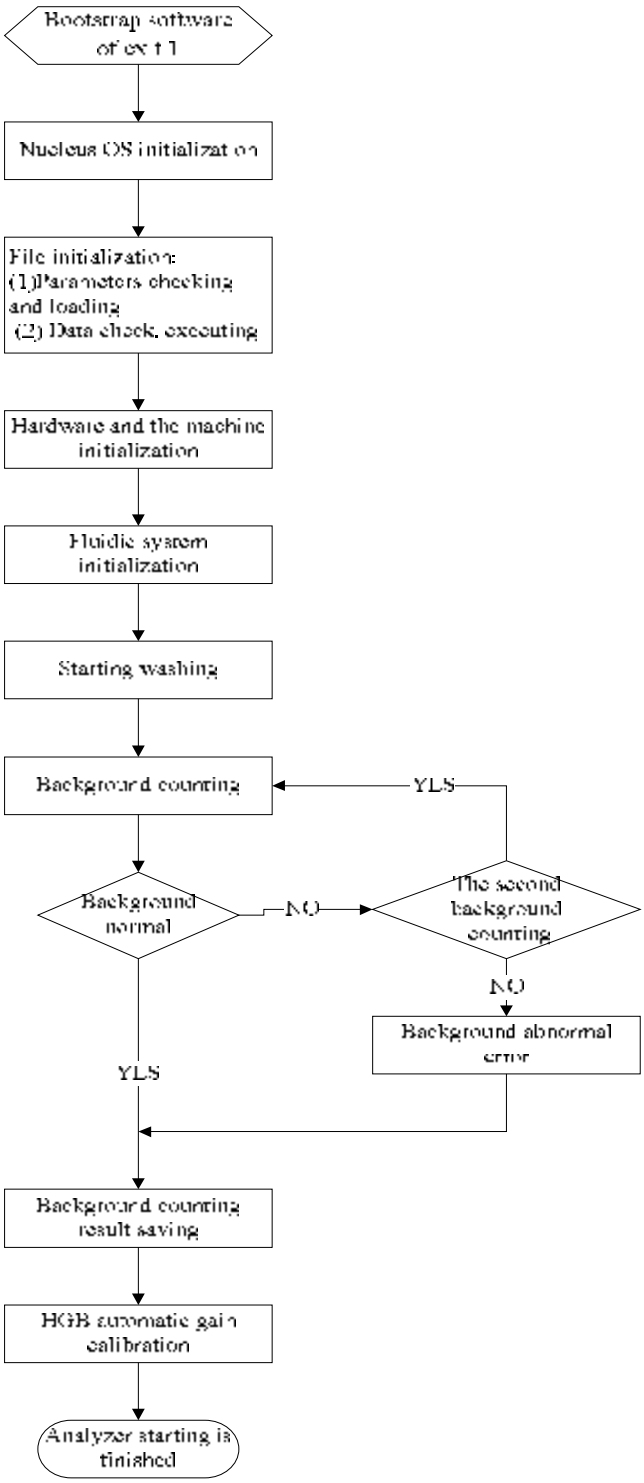


figure 5-3 System software initialization flow chart

1. After the system software is loaded, the starting logo and the relevant copyright information are displayed on the screen. Checking and loading setting: to check the validity of the configuration data, execute settings (important & common), then load them to the global variable.
2. Checking running data: to check the validity of data file produced during the analyzer

running, such as the sample data and the control data.

3. Initializing the hardware and the machine: to initialize the status and position of some hardware ports and machine moving parts.
4. Initializing the fluidic system: to self-test some fluidic units and initialize the status of the valves, pumps, constant-current source, zapping and HGB light.
5. The progress of files, hardware and fluidic initialization and the test result is displayed at the bottom center of the screen.
6. Starting cleaning: to execute the corresponding cleaning sequence according to the last shutdown mode. The system runs the background check after the cleaning is finished.
7. The system enters the counting screen after the system software initialization is finished.

Password

Level	Password	Operation menu	Functions
1	service engineer (3210)	count	(F5) digital oscillograph (↑) upgrade (including the version/configuration upgrade)
		review\table	(F5) special function: derived data
		review\histogram	(F5) check the sample special information and the numbers of valid samples
		setup\setup items	other language, sequence number gain fluidic system: the volume of the metering tube
		service\system test	(machine assembly) motor adjustment
		setup\log	check the sequence log (F2) derived log
		setup\configuration	check the high-level configuration (F1) derived configuration (F5) configuration comparison screen
2	administrator (2826)	setup\setup items	gain digital pot count parameter unit, count time (reference range) general/man/woman/child/neonate (other) background color of predilute mode
		review\table	(F5) special function: trend graph
		calibrator\manual	user calibrates manually
		calibrator\auto	user calibrates with calibrator
		calibrator\fresh	fresh blood calibration

3	user	/	

Software Upgrade

Upgrade Procedure

Upgrade the system software of the CPU through the upgrade disk. The upgrade procedure is as follows:

1. Copy the contents need upgrading from the subdirectory in the disk to a new floppy disk. Select all the content in the floppy disk and press the right key in the mouse to remove the read-only attribute. If one floppy disk is not enough, open the UPDATE.CFG file and in turn copy all the files in it to several floppy disks. The first floppy disk must include the relevant UPDATE.CFG file.
2. When the analyzer starts, it enters the "**Count**" screen automatically.
3. Select "**Setup→Password**" screen to set the password to be service engineer level.
4. Select the "**Count**" screen and press [↑]. The screen displays:

   "**Insert disk of config, then press [ENTER] key.**"
5. Insert the upgrade disk in to the floppy disk driver and press [ENTER]. The screen displays:

   "**Reading config file ...**"
6. The original software reads the new upgrade file and analyzes the upgrade demand. When the analysis is finished successfully, the screen displays:

   "**Insert disk of data, then press [ENTER] key.**"
7. Press [ENTER] and the original software reads the new files to the temporary catalog.
8. If one floppy disk is not enough, the screen displays:

   "Insert disk of following data， then press [ENTER] key."
9. After the new file reads successfully, the screen displays:

   "**Writing files to disk or flash ...**"
10. Then the original software reads the new file from the temporary catalog on the DOM, write it into the working catalog and then delete the file in the temporary catalog. The screen displays:

    "**Update is successes, wait for restarting ...**"
11. The analyzer restarts automatically after several minutes.
12. The upgrade is finished successfully.

Notes and the Error Alarms

1. During the upgrade process, the operator should always stay with the analyzer and mind every prompt in the analyzer.
2. During the upgrade process, the analyzer should be kept on. Or, the language library will be damaged and cannot be loaded normally. To repair it, re-install the DOM.
3. During the upgrade process, if “Delete the printing task first!” prompts, enter “Service”→ “Print” screen to delete all the print tasks before continuing the upgrade.
4. During the upgrade process, if “Transmitting. Please wait.” prompts, enter “Review→Sample Table Review→Transmit” screen to stop the transmitting task first, and then continue the upgrade.
5. During the upgrade process, if message prompts again and again as follows:

   “**Insert disk of config, then press [ENTER] key.**”

   Or

   “**Insert disk of data, then press [ENTER] key.**”

   Check whether it is the right upgrade disk and if not, change another right disk to re-upgrade. The analyzer will go back to the “**Count**” screen if the disk cannot read for 3 times.
6. If “**Update is failured, contact to Mindray Co. Ltd.**” displays, the analyzer will go back to the “**Count**” screen after 5 seconds. The system software cannot be loaded normally and “**File error**” may alarm in the future use. To repair it, re-install the DOM.

Setup

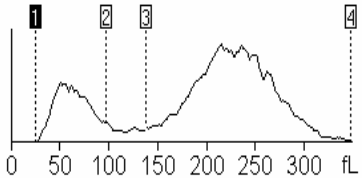
The system settings are factory default at the analyzer’s first startup. To satisfy different requirements, some settings may be customized. Some customization may require the administrator password (2826). See the operation manual of BC-2300 for detailed setting.

6 Histograms and Pulse Graphs

Histograms

This section demonstrates some usual WBC histograms.

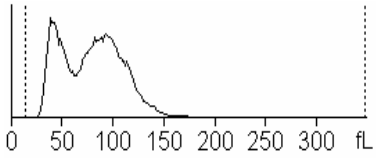
1. Normal histogram



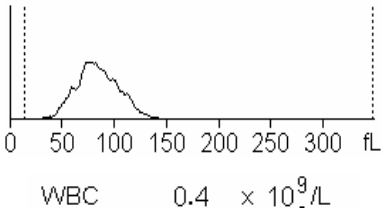
⚠**NOTE**⚠:

Blood cells lain between the first and the second discriminators are lymphocyte; those between the second and the third discriminators are mid-sized cells; those between the third and the fourth discriminators are granulocyte. The fourth discriminator is the fixed line.

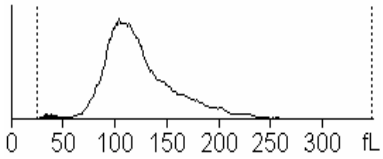
2. No differential result because the WBC histogram is over-narrowly compressed.



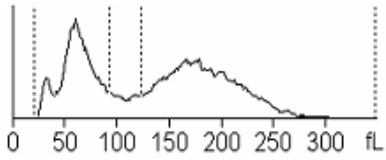
3. No differential result because WBC count result is less than a certain value (WBC < 0.5).



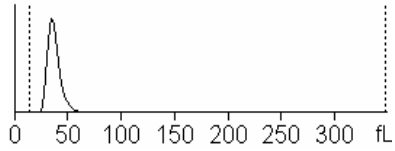
4. No differential result because the peak of WBC histogram lies in the middle of the histogram and thus cannot identify the type of peak cells.



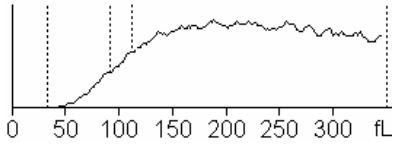
5. Increased nucleated erythrocytes or interference or inadequate hemolysis.



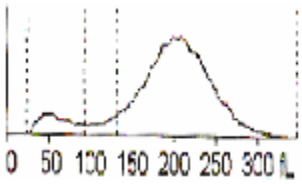
6. Severe interference in WBC channel (identifying if it is interfered by observing the pulse graph)



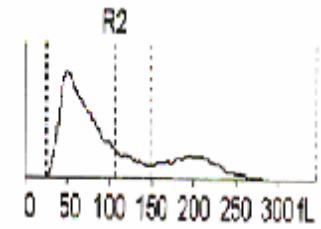
7. No lyse reagent or poor hemolysis



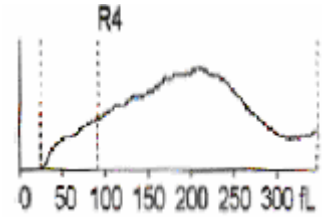
8. Increased neutrophilic granulocytes



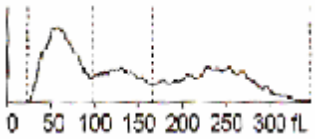
9. Increased lymphocytes



10. Tumor patient



11. Increased mid-sized cells



Pulse Graphs

After each count, the system can save the original sampling pulses of this time. We can analyze the reason leading to the fault by viewing these original data.

Enter password “3210”, after a count, you can view the WBC pulse graph of this count by pressing [F5] and view RBC pulse graph, PLT pulse graph by pressing [F1]. Presses [ENTER] to exit.

When the instrument is working normally, the length of pulse data is related to the concentration of the blood sample. The length of the pulse data should be within a limit range. For general samples, the range should be:

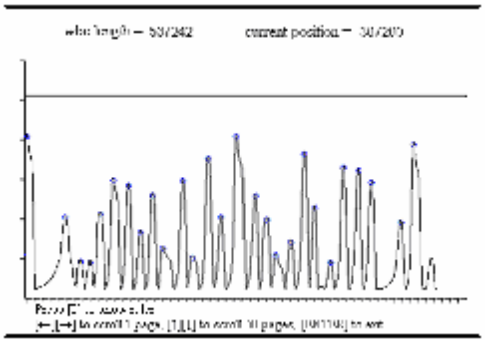
WBC: < 1M RBC: < 600K PLT: < 1M

Length of normal level controls data should be:

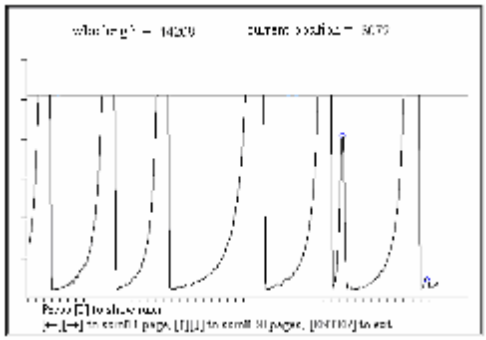
WBC: 400 - 700K RBC: 250 - 450K PLT: 300 - 600K

Data length of abnormal sample will not lie in this range.

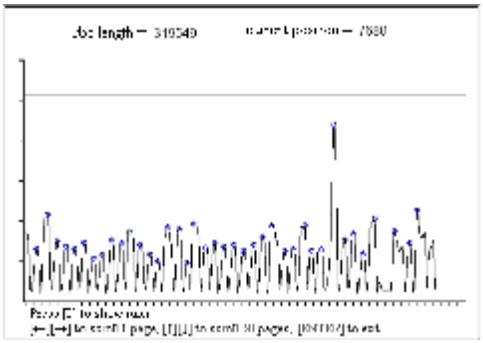
Normal Pulse Graphs



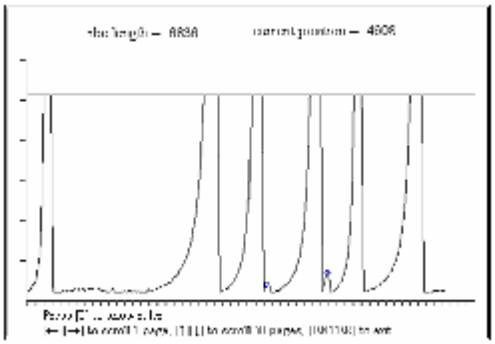
WBC pulse graph of normal sample



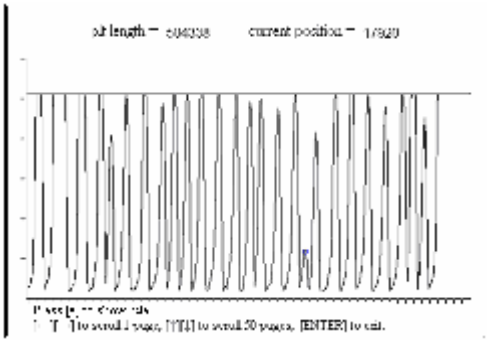
Pulse graph of normal WBC background



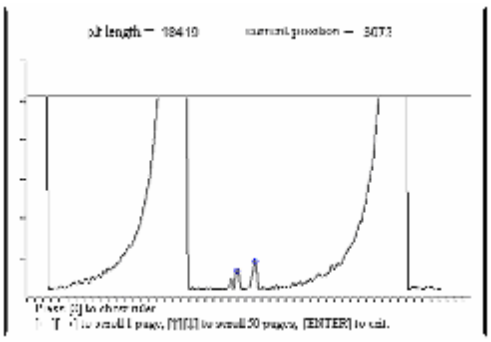
RBC pulse graph of normal sample



Pulse graph of normal RBC background

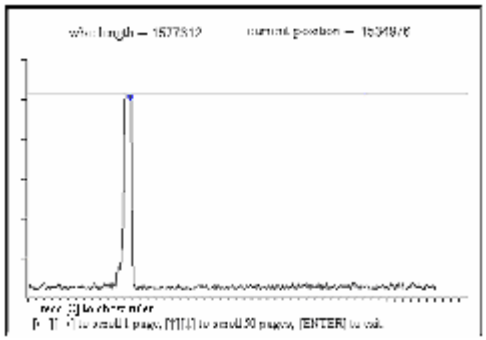


PLT pulse graph of normal sample



Pulse graph of normal PLT background

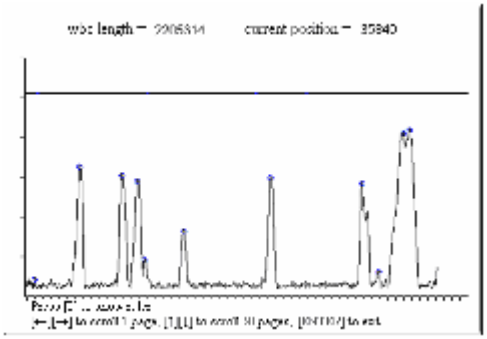
Abnormal Pulse Graphs



Severe interference in WBC channel

Data length increases obviously

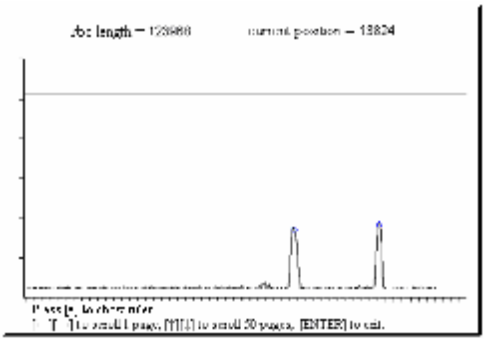
(background)



Severe interference in WBC channel

Data length increases obviously

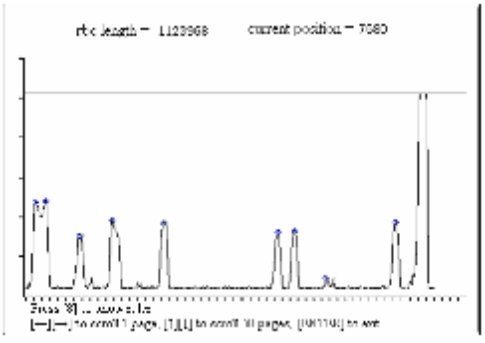
(normal sample)



Severe interference in RBC channel

Data length increases obviously

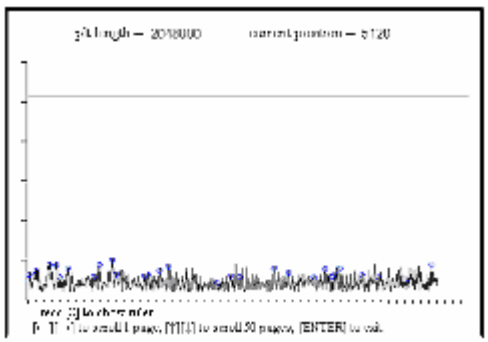
(background)



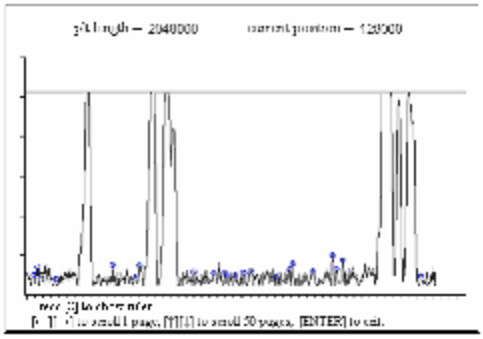
Severe interference in RBC channel

Data length increases obviously

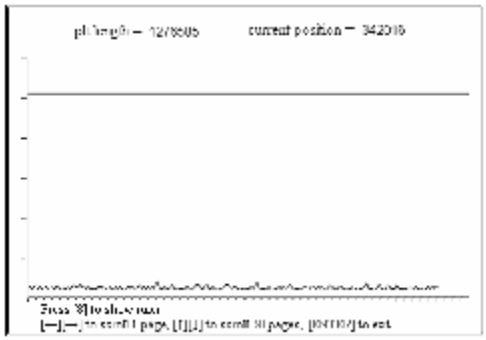
(normal sample)



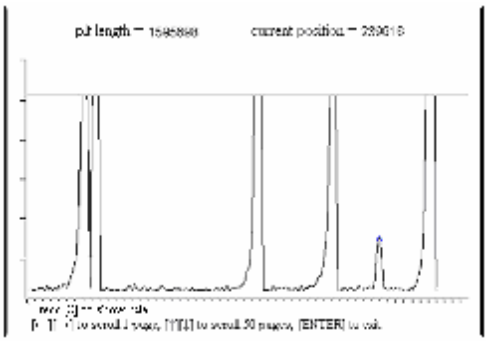
Severe interference in PLT channel
Data length increases obviously
(background)



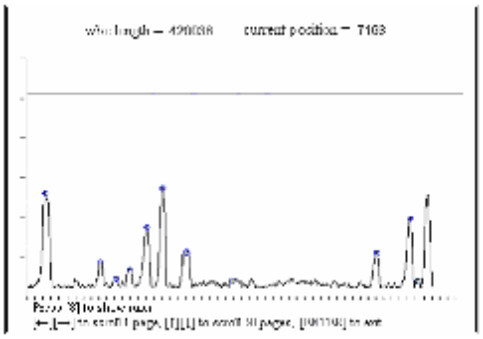
Severe interference in PLT channel
Data length increases obviously
(normal sample)



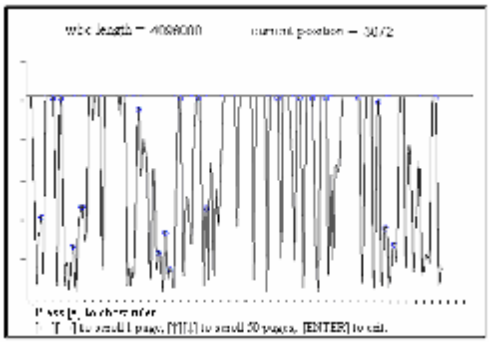
Interference occurs because
gain of PLT channel is too large
Data length increases (background count)



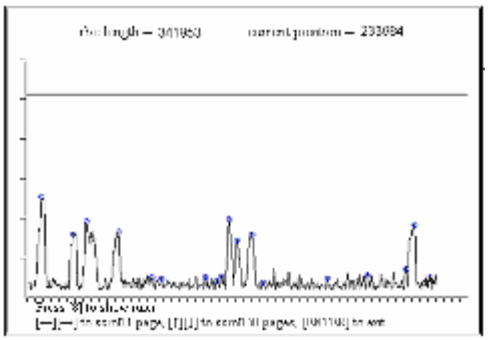
Interference occurs because
gain of PLT channel is too large
Data length increases (normal sample)



Slight interference in WBC channel
Data length does not increase obviously
(normal sample)



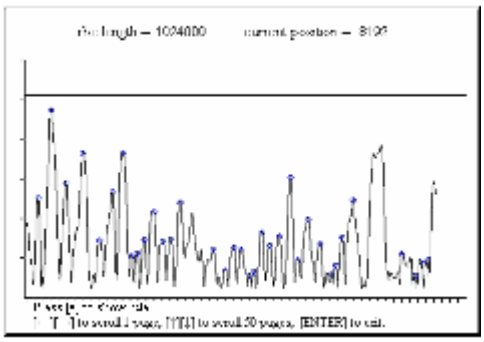
Inadequate or no hemolysis in WBC channel
Data length increases



Slight interference in RBC channel

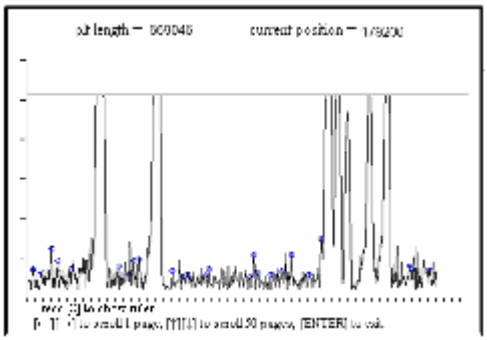
Data length does not increase obviously

(normal sample)



Sample of too dense concentration in RBC channel

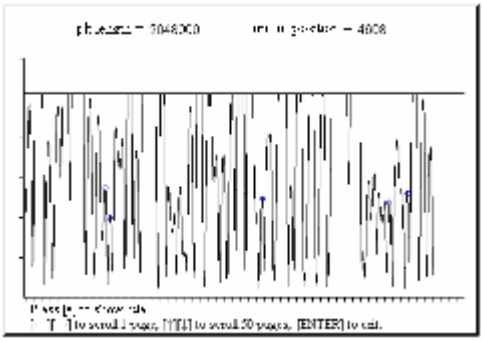
(Does not occur in normal situation)



Slight interference in PLT channel

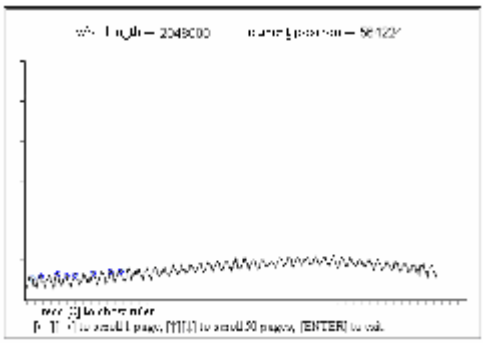
Data length does not increase obviously

(normal sample)



Sample of too dense concentration in PLT channel

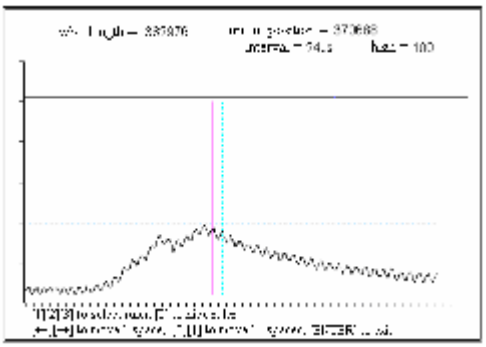
(Does not occur in normal situation)



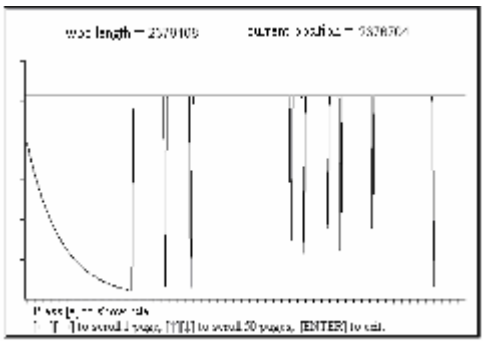
Interference in WBC channel

caused by inverter

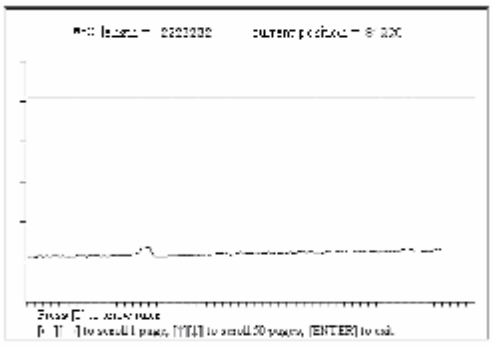
Feature: sine wave with cycle of 20～26us



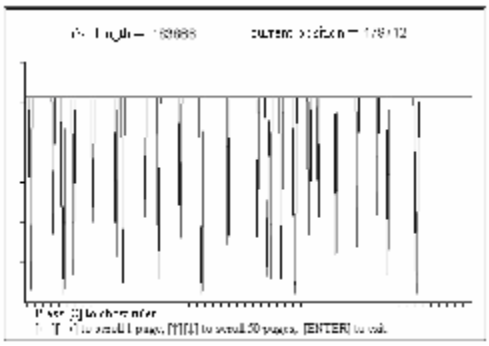
Measuring interference from inverter



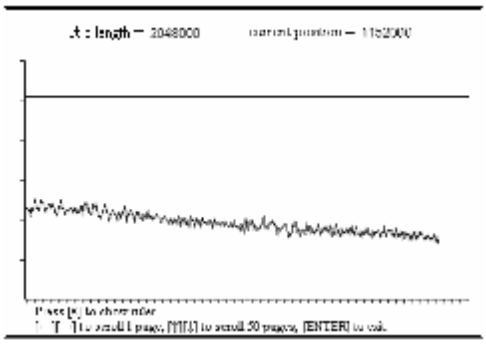
Insufficient liquid in WBC bath during count



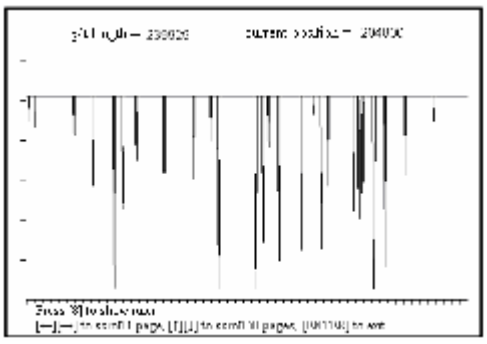
Interference in WBC channel from tubing
Feature: data length increases,
the base line of signal is not stabile.



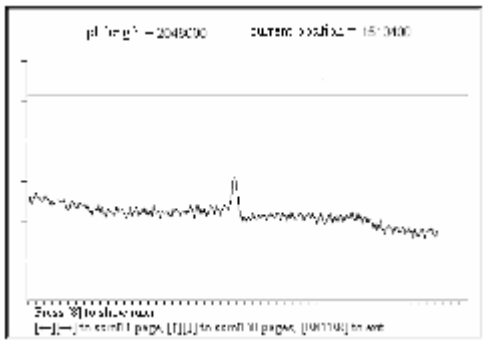
Insufficient liquid in RBC bath during count



Interference in RBC channel from tubing
Feature: data length increases,
the base line of signal is not stabile.



Insufficient liquid in PLT bath during count



Interference in PLT channel from tubing
Feature: data length increases,
the base line of signal is not stabile.

7 Troubleshooting

The chapter deals with the codes, possible causes and solutions of the errors. If the error remains after you have tried the recommended method, check the hardware and replace the fittings or PCB boards which are suspected of causing the error.

This chapter consists of two parts, the first part dealing with the errors and assigned error codes and the second possible causes and recommended solutions.

⚠ CAUTION

- **Unless otherwise instructed, always turn off the power before trying to assemble/disassemble your analyzer or fix the error.**
- **The leakage of the liquid from the analyzer can cause personnel injury or property damage. In case of leakage, be sure to turn off the analyzer immediately and wipe off the liquid.**
- **All the analyzer components and surfaces are potentially infectious, take proper protective measures for operation or maintenance.**
- **Samples, controls, calibrators and waste are potentially infectious. Wear proper personal protective equipment (e.g. gloves, lab coat, etc.) and follow safe laboratory procedures when handling them in the laboratory.**
- **Be sure to keep you hair, clothes, cuffs or hands away from the moving parts of this analyzer.**
- **Be sure to use specified tools or parts to maintain this analyzer and be sure to clean the used tools as instructed by their instruction manual after the maintenance is done.**
- **Be sure to use soft and clean cloth, or neutral detergent-soaked cloth (twisted dry), or soft cloth washed by ethanol to clean the surface of this analyzer.**
- **Be sure to pay attention to the marks or symbols on this analyzer. Be sure not to touch the power socket at the back of this analyzer with wet hands or wet rags.**
- **Be sure not to use organic solvent or acid/alkaline detergent to wash the surface of this analyzer. Otherwise, the surface may fade or become corrupted.**
- **Be sure to avoid direct contact with the reagents that will hurt your eyes, skin and diaphragm.**
- **In case you spill the reagents on you skin, be sure to wash them off with much water. In case you spill the reagents into your eyes, be sure to**

immediately wash your eyes with much water and go see a doctor for further treatment.

Error Code

The errors recorded in the log are presented in the error codes. See table below for the correspondence between the errors and error codes.

Table 7-1 Errors and codes

Code	Error	Code	Error	Code	Error
0401	Environmental Temperature Abnormal	0402	Background abnormal	0403	HGB error
0404	HGB adjust	0405	WBC clog	0406	WBC bubbles
0407	RBC clog	0408	RBC bubbles		
0801	Communication error	0802	Scanner error	0803	Scanner communication error
1001	Printer out of paper	1002	Printer connection error	1003	Recorder communication error
1004	Recorder out of paper	1005	Recorder too hot	1006	Press bar up
2001	Lyse out	2002	Diluent expired	2004	Lyse expired
2005	Negative pressure filter error	2006	Positive pressure filter error	2007	Real-time clock error
4002	Syringe motor error	4005	A/D error	4008	Vacuum error
4009	Pressure error	400B	Diluent out	400D	Waste full
4011	56V power supply error	8001	File error	8002	Dynamic memory error

Solutions

This chapter presents possible causes and solutions to be taken when the errors occur.

NOTE

- **Perform validation after removing the errors.**

56V Error

Something is wrong with the 56V voltage on the analog board. and the operation to the fluidic system is not allowed.

Solution:

Access "**Service** → **Self-test**" to test the 56V voltage.

The error will be cleared if the test result is normal. Otherwise, turn off the analyzer, change the analog board, and then restart to check again.

A/D Error

Something is wrong with the A/D converter on the CPU board, and the operation to the fluidic system is not allowed.

Solution:

Access "**Service** → **Self-test** → **Circuit**". Test the A/D interrupt.

The error will be cleared if the test result is normal. Otherwise, change the CPU board and restart the analyzer to check again.

Dynamic Memory Error

Something is wrong with the system memory.

Solution:

Turn off the analyzer and check the connecter or change the CPU board, and then restart the analyzer to check again.

HGB Error

HGB blank voltage is within 0V-3.2V or 4.9V-5V.

Solution:

Check the blank after the performance of probe cleanser cleansing. If the error cannot be cleared, check the HGB blank voltage for several times. If the voltage is stable but out of range, follow the procedure below,

1. Access "**Setup → Password**" to gain the administrator authority.
2. Access "**Setup → Settings → Gain**" to adjust the HGB blank voltage to 3.4-4.8V (4.5V recommended)**.** If the cannot be cleared, try to clean the sending and receiving end of the HGB shelf illuminant by a blower; wipe out the possible fluidic leakage from the bath with lint free tissue.

HGB Adjustment

HGB blank voltage is within 3.2 - 3.4V or 4.8- 4.9V.

Solution:

Check the blank after the performance of probe cleanser cleansing. If the error cannot be cleared, check the HGB blank voltage for several times. If the voltage is stable but out of range, follow the procedure below,

1. Access "**Setup → Password**" to gain the administrator authority.
2. Access "**Setup → Settings → Gain**" to adjust the HGB blank voltage to 3.4-4.8V (4.5V recommended)**.** If the cannot be cleared, try to clean the sending and receiving end of the HGB shelf illuminant by a blower; wipe out the possible fluidic leakage from the bath with lint free tissue.

If the error still remains, try to change the HGB shelf or such relevant parts as analog board.

RBC Clog

This error message occurs when the actual RBC count time is greater than the preset RBC count time by 2 seconds.

Possible causes:

Clogged aperture; inappropriate RBC count time settings or solenoid valve error.

Solution:

1. Access “Service → Maintenance” and do the “Zap aperture” and “Flush aperture” procedures.
2. After unclogging, access “Setup → Settings → Count” to note down the preset RBC count time. Access “Service → Self-test →Tubing” and test the actual RBC count time.
3. If the tested time differs from the preset time by less than 2 seconds, it means the unclogging is successful and you can return to the Count screen to continue the analysis. Otherwise, access “Service → Maintenance” to soak the bath and tubing with probe cleanser.
4. When the soaking is done, access “Setup → Settings → Count” to note down the preset RBC count time. Access “Service → Self-test → Tubing” and test the actual RBC count time.
5. If the tested time differs from the preset time by less than 2 seconds, it means the unclogging is successful and you can return to the “Count” screen to continue the analysis. If the difference is still greater than 2 seconds and stabilized around a certain value, access “Setup → Settings → Count” to change the RBC count time accordingly. After the adjustment, test the actual count time again and make sure the difference is within 2 seconds.
6. If the error still remains, try to check whether the solenoid valve of the back bath is clogged or the metering tube is polluted. Then check whether fluid runs along one side of the metering tube wall during the analysis, if so, the count time may be longer or when the count cycle stops cannot be detected.
7. The pollution of metering tube may be caused by rinse expired, remind the user of using designated rinse within the expiration date. The circuit board of volumetric unit may be not sensitive enough or the photocoulpler is damaged. Try to change the relevant part.

RBC Bubbles

This error message occurs when the actual RBC count time is less than the preset RBC count time by 2 seconds.

Possible causes:

Insufficient diluent or rinse;

Loose tubing connection;

Inappropriate RBC count time setting.

Solution:

1. Check whether the diluent or rinse is sufficient. If not, change a new container of diluent of rinse.
2. Check the tubing connections. If necessary, reconnect the tubing.
3. If the error still remains, access “Setup → Password” to gain the administrator

authority and then access “Setup → Settings → Count” and adjust the RBC count time.

4. If the error still remains, check whether the air filter above the metering tube is dirty or abnormal; if so, change it and than check again.
5. If the error still remains, check whether the solenoid valve between the air filter and the metering tube is abnormal; if so, change the valve.
6. If the error still remains, check whether there is such air leakage as the solenoid valve air leakage during the analysis; otherwise, check whether the photocoulpler’ sensitivity of the metering tube is abnormal; if so, readjust the sensitivity or change the volumetric unit.

WBC Clog

This error message occurs when the actual WBC count time is greater than the preset WBC count time by 2 seconds.

Possible causes:

Clogged aperture; Inappropriate WBC count time settings or solenoid valve error.

Solution:

Refer to solution of the RBC clog.

WBC Bubbles

This error message occurs when the actual WBC count time is less than the preset WBC count time by 2 seconds.

Possible causes:

Insufficient diluent or rinse;

Loose tubing connection;

Inappropriate WBC count time setting.

Solution:

Refer to the solution of RBC bubbles.

Background Abnormal

At least one parameter failed the background check.

Solution:

1. At the **“Count**” screen, press [F3] to do the startup procedure. If the error still remains, access “**Service → Maintenance**” and do the “**Probe cleanser**

cleaning" procedure. After the cleaning is done, return to the "**Count**" screen and check the background again to see whether the error is cleared.

2. If the error still remains, check whether the reagents are expired or polluted; if so, change the reagents and check again; if not, check whether there is outer interference.
3. Make sure that there is no such brushing type device as electric drill is working discontinuously.
4. Make sure that the bath shielding box is properly connected, the shielding box is properly connected to the analog board, and the analog board shielding box is properly connected.
5. Make sure that the fluidic below the bath and back bath is not polluted; if so, do the probe cleanser cleaning procedure. If the error still remains, change the tubing.

Printer Out of Paper

Possible cause:

The printing paper has run out or is not correctly installed.

Solution:

Check whether the printer is out of paper. If so, load paper to the printer; otherwise, re-install the existing paper.

Printer Connection Error

Check whether the printer is well connected to the analyzer.

Waste Full

Possible cause:

1. The waste container is full.
2. After the performance of the analyzer's first startup, draining the fluidic system or turning on the analyzer after the packing performance.

Solution:

1. Check whether the container is full. If so, empty the container, or change a new container to receive the waste.
2. If not, access the "**Setup** → **Setting** → **Reagents**" to re-set the waste container volume according to the instruction 5.2.1 of the operation manual.

Negative Filter Error

Something is wrong with the vacuum negative filter, the error is reported and the operation to the fluidic system is not allowed.

Solution:

Access "**Service → Self-test → Tubing**" and test the negative pressure according to the instruction 10.4.1 of the operation manual. The error will be cleared if the result is normal; otherwise, try to change the negative filter connecting the valve 7 or check whether the fluidic unit connecting the negative filter is free.

Environmental Temperature Abnormal

Possible causes:

Abnormal environmental temperature or malfunctioning temperature sensor.

Solution:

Access "**Service → Status**" and check the environmental temperature. If the temperature exceeds the specified range by 15℃-30℃, you need to adjust the work environment of this analyzer so that the analyzer works in the required environment. If the temperature is within the required range but the error remains, try to change the temperature sensor or the CPU board and check again.

Recorder Out of Paper

Possible causes:

Recording paper has run out or is not correctly installed.

Solution:

Check whether the recording paper has run out. If so, load new paper; if not, re-install the existing paper. If the error still remains, check whether there is remaining paper in the recorder. If so, take it out and re-install paper; if not, try to restart the analyzer or change the recorder.

Recorder Communication Error

Solution:

Try to restart the analyzer. If the error is not cleared, change the recorder. If the error still remains, try to change the relevant CPU board or power supply board.

Recorder Too Hot

Possible causes:

The recording head overheats.

Solution:

1. Stop using the recorder for some minutes to make it cooling.
2. If the error repeats, try to clean the rubber wheel of the print head; if the error still remains, try to change the recorder.

Press Bar Up

Solution:

Check the recorder and do according to the step 1 then step 3 in the instruction 4.3.2 of the operation manual. If the error still remains, try to change the recorder.

Real-Time Clock Error

Something is wrong with the clock, error is reported and the operation to the fluidic system is not allowed.

Solution:

Access "**Setup → Settings → Date & Time**" and set the time and date according to the instruction 5.2.3 of the operation manual, and then restart the analyzer to enable the new settings. If the error still remains, try to change the 3V battery on the CPU board or the relevant CPU board.

Scanner Error

Solution:

1. Check whether the scanner model is as required;
2. check whether the bar code is too long or is invalid;
3. check and make sure the bar code is correct.
4. If the error still remains, change the new barcode scanner or the relevant CPU board.

Scanner Communication Error

Something is wrong with the communication between the scanner and the analyzer.

Solution:

1. Check the connection between the two devices;
2. check whether the scanner model is as required.

Communication Error

Possible causes:

The received communication settings are different from the analyzer.

Solution:

Access "**Setup → Settings → Print & comm.** " and change the communication settings according to the instruction 5.2.2 of the operation manual.

File Error

Something is wrong with file saving.

Solution:

Try to restart the analyzer. If the error is not cleared, try to insert the DOM on the CPU board and restart the analyzer to check. If the error still remains, try to change the DOM or the relevant CPU board.

Lyse Expired

Possible causes:

The lyse has expired or its expiration date is not correctly set and the operation to the fluidic system is not allowed.

Solution:

Check whether the lyse has expired. If so, change a new container of lyse according to the instruction 4.3.1 of the operation manual**;** if not, access "**Setup → Settings → Reagents**" and adjust the expiration date according to the instruction 5.2.1 of the operation manual.

Diluent Expired

Possible causes:

The diluent has expired or its expiration date is not correctly set and the operation to the fluidic system is not allowed.

Solution:

Check whether the diluent has expired. If so, change a new container of diluent according to the instruction 4.3.1 of the operation manual; if not, access "**Setup → Settings → Reagents**" and adjust the expiration date according to the instruction 5.2.1 of the operation manual.

Lyse Out

Possible causes:

Insufficient lyse or wrong lyse volume setting; after the performance of the analyzer's first startup, draining the fluidic system or turning on the analyzer after the packing performance.

Solution:

Check whether there is sufficient lyse left. If so, access "**Setup → Settings → Reagents**" and adjust the remaining lyse volume according to the instruction 5.2.1 of the operation manual; If not, change a new container of lyse according to the instruction 4.3.1 of the operation manual.

Diluent Out

Possible causes:

insufficient diluent or wrong diluent volume setting; after the performance of the analyzer's first startup, draining the fluidic system or turning on the analyzer after the packing performance.

Solution:

Check whether there is sufficient diluent left. If so, access **"Setup → Settings → Reagents**" and adjust the remaining diluent volume according to the instruction 5.2.1 of the operation manual; If not, change a new container of diluent according to the instruction 4.3.1 of the operation manual.

Pressure Error

The vacuum chamber does not reach the expected pressure within the given time, the error is reported and the operation to the fluidic system is not allowed.

Solution:

Access "**Service → Self-test → Tubing**" and test the pressure according to the instructions 10.4.1 in the operation manual. The error will be cleared if the result is normal; otherwise, check the relevant fluidic unit and analog board.

Vacuum Error

The system does not reach the expected vacuum within the given time, the error is reported and the operation to the fluidic system is not allowed.

Solution:

Access "**Service → Self-test → Tubing**" and test the vacuum according to the instructions 10.4.1 in the operation manual. The error will be cleared if the result is normal; otherwise, check the relevant fluidic unit and analog board.

Positive Filter Error

The system does not reach the expected vacuum within the given time, the error is reported and the operation to the fluidic system is not allowed.

Solution:

Access "**Service → Self-test → Tubing**" and test the positive filter according to the instructions 10.4.1 in the operation manual. The error will be cleared if the result is normal; otherwise, try to change the positive filter connecting with valve 8 or check whether the fluidic unit connecting with the positive filter is free.

Syringe Motor Error

Possible causes:

Something is wrong with the motor that controls the syringe that aspirates/dispenses samples and reagents.

Solution:

Access "**Service → Self-test → Machine**" and test the motor according to the instructions 10.4.2 in the operation manual. The error will be cleared if the result is normal; otherwise, check the relevant machine part, fluidic unit, drive board and photocoupler detecting part.

Note that the fluidic clog may also cause the syringe error; the fluidic should be checked too.

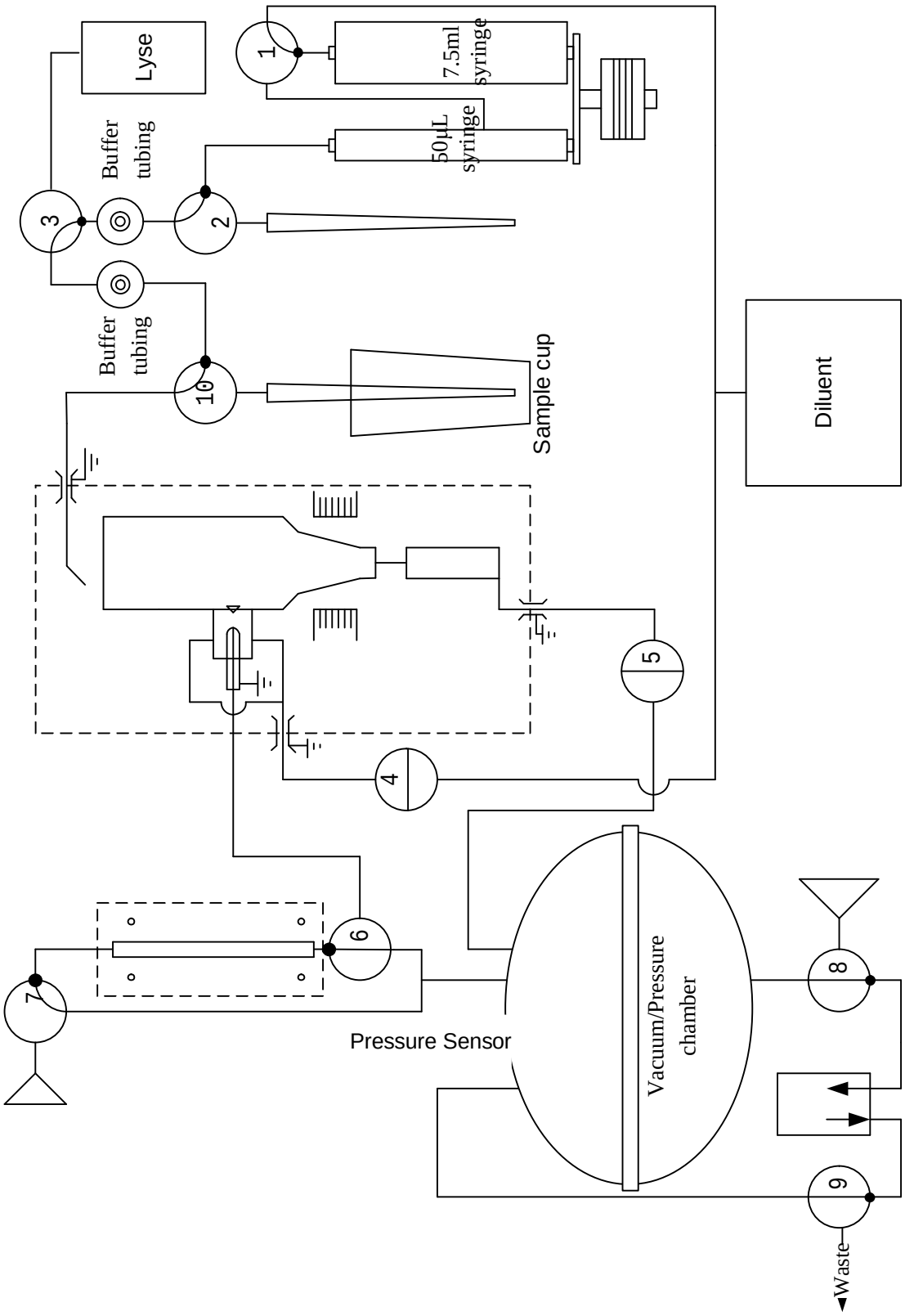
⚠ CAUTION

- **Be sure to keep you hair, clothes, cuffs or hands away from the motor the analyzer is power on.**

8 List of Spare Parts

P/N	Description
0000-10-10932	Keyboard (88 keys) KT-88
2800-30-28714	2800 recorder assembly
59BR-10-08830	ALPS PTMBL1306A thermal head
TR6D-30-16662	TR60-D recorder drive board
2002-20-55126-52	keypad panel
2800-30-28664	Keypad board
2800-30-28715	LCD assembly
900E-10-04913	INVERTOR CXA-L0612-VJL 'TDK'
0000-10-10907	Disk-on-module (32M) 44PIN 2.0mm 'M-SYSTEMS'
2800-30-28650	CPU board
2002-30-55101	Analog board
2002-30-55102	Drive board
2800-30-28668	Volumetric metering board
2800-30-28670	Power supply board
2000-10-06120	Waste pump
2002-30-55229	bath assembly
2000-20-03124	Ruby Red Cell Counter 80um RB-22084
0030-30-13194	Bath assembly without ruby
2800-30-28815	HGB assembly
0030-10-13064	Syringe motor 43F4J-05-010 'HSI'
2800-30-28779	7.5mL syringe assembly
2800-30-28780	50µL syringe assembly
2002-20-55106	Shielding box cover
3001-10-07054	Air filter
3001-30-07273	Vacuum/pressure chamber
0030-30-07586	Three-way mini solenoid valve
0030-30-07587	Two-way mini solenoid valve
2800-30-28817	CAP component for LYSE
2800-30-28818	CAP component for DILUENT
0200-20-05560	Diluent dispenser
3003-20-34949	Isolation chamber

A Fluidic System



B Error Code Description

Code	Error
0401	Envir. temp. abnormal
0402	Background abnormal
0403	HGB error
0404	HGB adjust
0405	WBC clog
0406	WBC bubbles
0407	RBC clog
0408	RBC bubbles
0801	Communication error
0802	Scanner error
0803	Scanner communication error
1001	Printer out of paper
1002	Printer connection error
1003	Recorder communication error
1004	Recorder out of paper
1005	Recorder too hot
1006	Press bar up
2001	Lyse out
2002	Diluent expired
2004	Lyse expired
2005	Negative filter error
2006	Positive filter error
2007	Real-time clock error
4002	Syringe motor error
4005	A/D error
4008	Vacuum error
4009	Press error
400B	Diluent out
400D	Waste full
4011	56V error
8001	File error
8002	Dynamic memory error

P/N: 2002-20-55223(V1.0)