

DP-6600

Digital Ultrasonic Diagnostic Imaging System

Service Manual

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- the product is used in accordance with the instructions for use.

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Note

This equipment is not intended for family usage.

This equipment must be operated by skilled/trained medical professionals.

Warning

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 this product is shipped to Mindray for service (this includes customs charges).
3. Return address: Please send the part(s) or equipment to the address offered by Customer Service department

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Safety Precautions

1. Meaning of Signal Words



In this operation manual, the signal words **⚠ DANGER**, **⚠ WARNING**,

⚠ CAUTION and **NOTE** are used regarding safety and other important instructions.

The signal words and their meanings are defined as follows. Please understand their meanings clearly before reading this manual.

Signal word	Meaning
⚠ DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTE	Indicates a potentially hazardous situation which, if not avoided, may result in property damage.

2. Meaning of Safety Symbols

Symbol	Description
	Type-BF applied part NOTE :All ultrasound transducers can be connected to this system are Type-BF applied part.
	"Attention" indicates the points requiring attention. Be sure to read the operation manual concerning these points before using the equipment.

3. Safety Precautions

Please observe the following precautions to ensure patient and operator safety when using this system.

- ⚠CAUTION:**
1. Display the most suitable image and select the most suitable measurement mode for the intended measurement. The results must be determined by a specialist.
 2. The basic measurement results are not displayed in the exam report.
 3. Be sure to perform measurement within images. If the area is outside the image, incorrect diagnosis may result.
 4. The detailed precautions for each measurement are described in the corresponding section. Read and understand these precautions before performing the measurement.
 5. Data in temporary storage areas, such as the CINE memory, is deleted when the power supply is turned OFF or when the Patient switch is pressed. Such data may also occasionally be deleted due to accidents. To minimize the possibility of reexamination being required as a result of unintended data deletion, back up the required images on external storage media.
 6. Refer to the Operation Manual (Fundamentals) for precautions regarding the use of this system.

Chapter1 General Description

1.1 Introduction

DP-6600 is a portable digital diagnostic ultrasound system, which features black & white imaging.

1. Front view

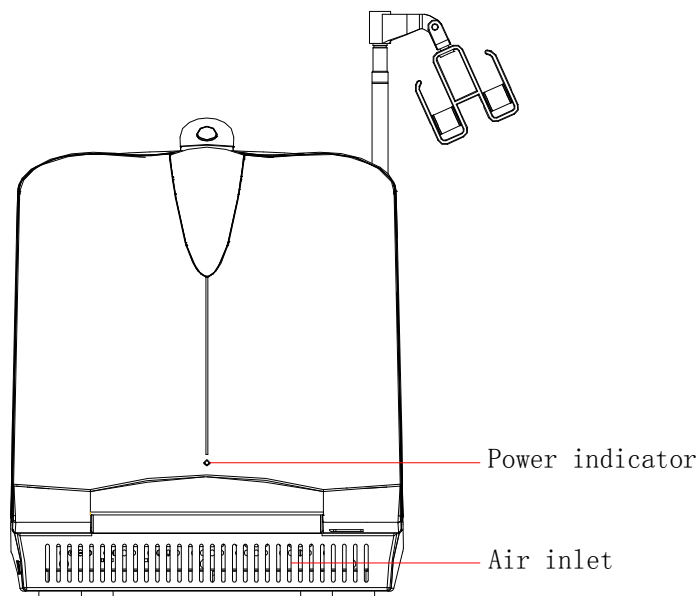


Figure 1-1 Front view

2. Rear view

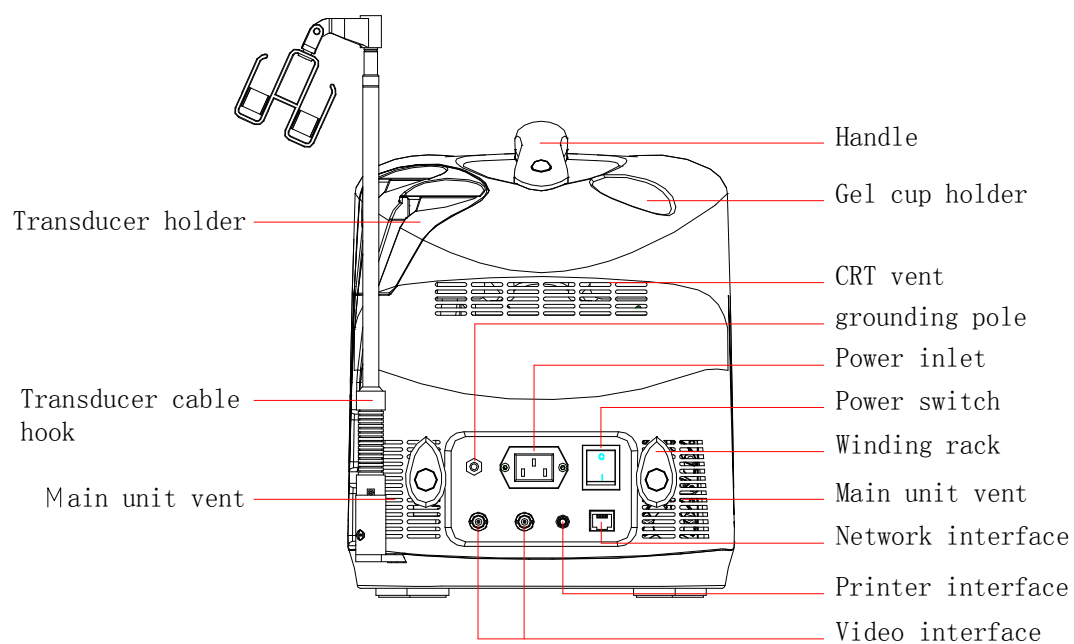


Figure 1-2 Rear view

3. Left view

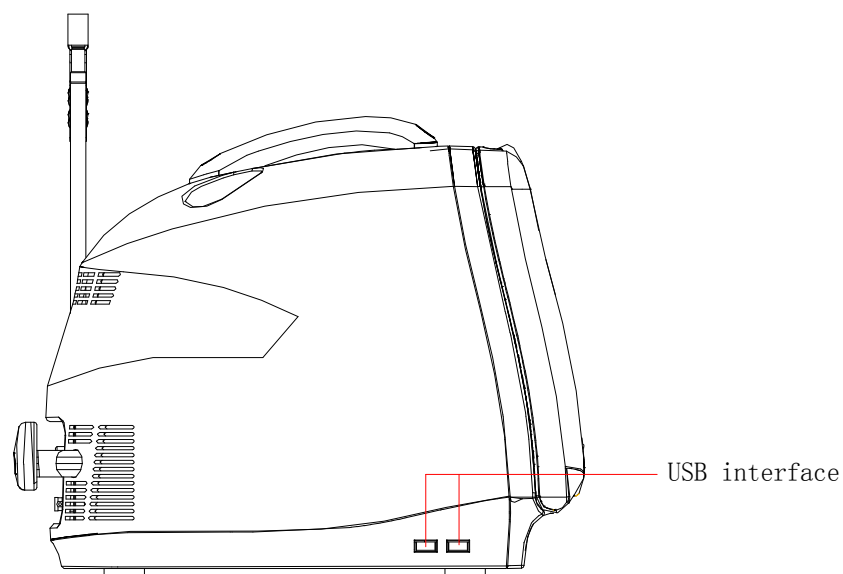


Figure 1-3 Left view

4. Right view

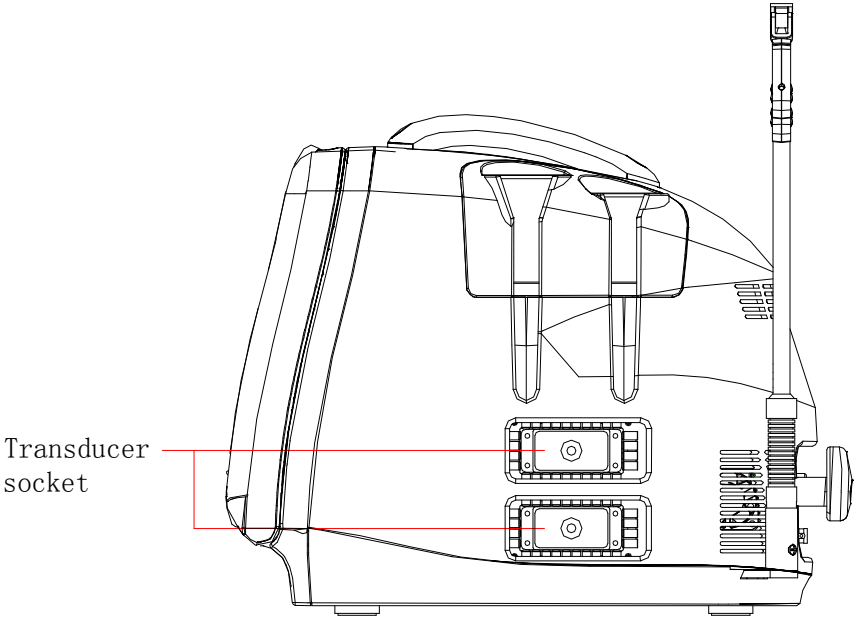


Figure 1-4 Right view

5. Elevation view (with the keyboard unfolded)

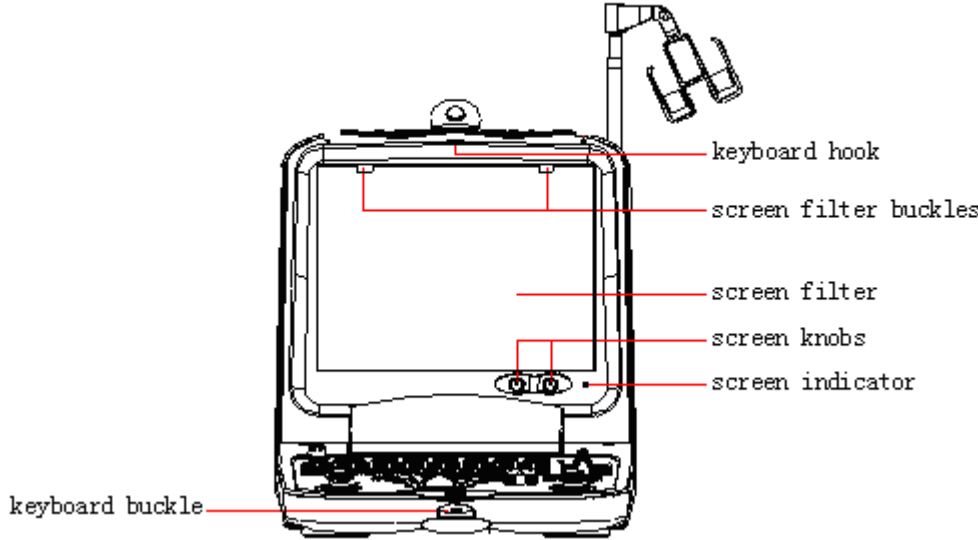


Figure 1-5 Elevation view (with the keyboard unfolded)

1.2 Preparation for Repair

The needed tools and measurement devices are shown as followed:

Table 1-1 Tools and Devices for Repair

Tool	Model	Manufacturer	Spec./Standard
Screwdriver (various sizes and types)			Unspecified
Flat-headed screwdriver (large)			Unspecified
Wire nippers			Unspecified
Needle nose pliers			Unspecified
Diagonal pliers			Unspecified
Soldering iron and stand			Unspecified
Desoldering tool			Unspecified
Wrench set			Unspecified
Adjustable wrench			Unspecified
Tweezers			Unspecified
Hammer			Unspecified
Metric Allen wrench set			Unspecified
File (various types)			Unspecified
Cutter			Unspecified

Table 1-2 Consumable Material

Consumable Material	Model	Manufacturer	Specification/Standard
Insulation tape			Unspecified
Hishilite tube, Empire tube (various types)			Unspecified
Wires (various types)			Unspecified
Screws, nuts, washers (various types)			Unspecified
Solder			
Paper file (various types)			
Ethanol for cleaning and disinfection			

1.3 Schematic Diagram

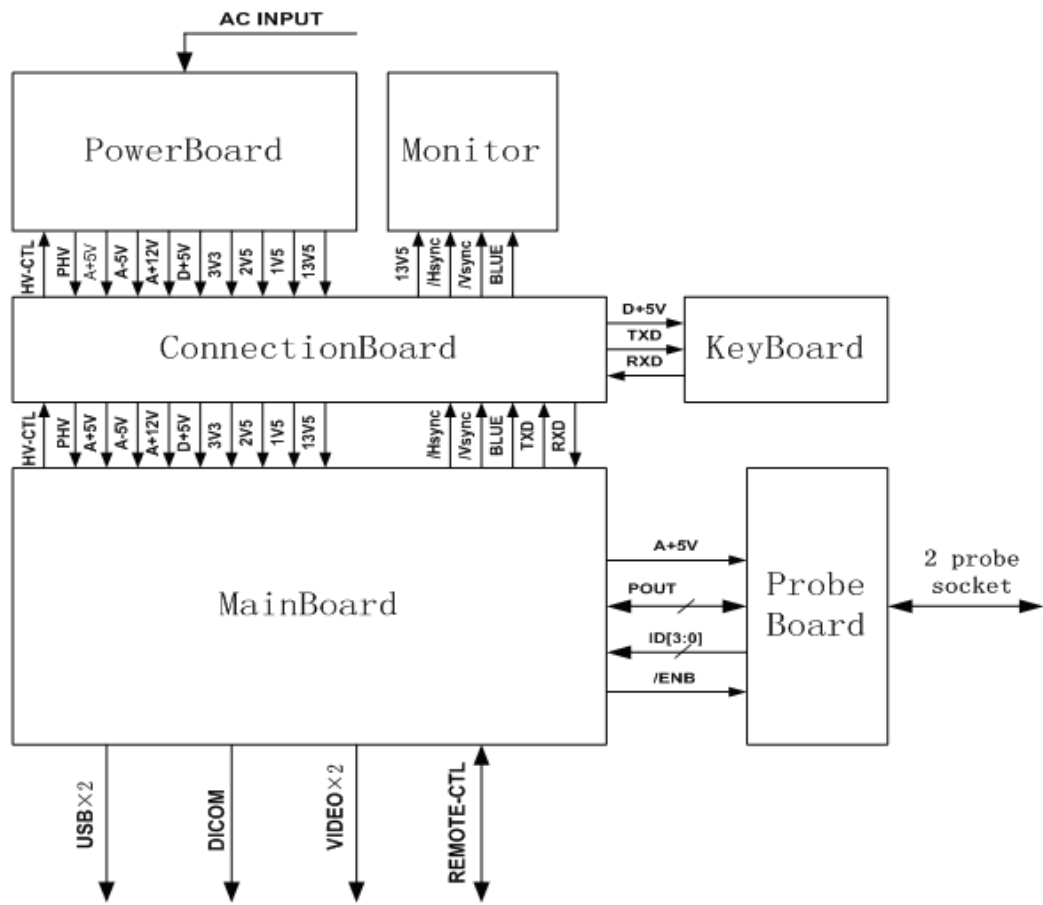
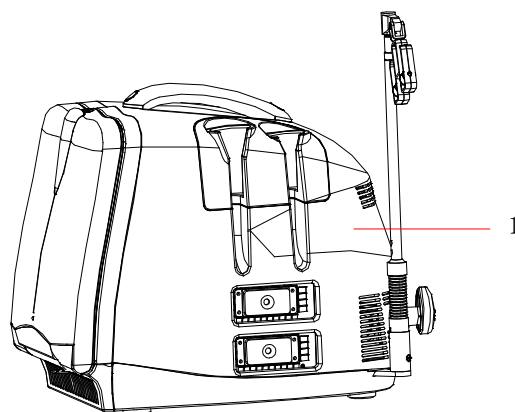


Figure 1-6 Schematic Diagram

Chapter2 Structure of the Complete Machine & Disassembly

2.1 Structure of the Complete Machine

2.1.1. The appearance view of the main unit



1.Main unit 2300-30-29157

Figure 2-1 The appearance view of the main unit

2.1.2. The exploded drawing of the complete machine

2.1.2.1. The exploded drawing of the complete machine

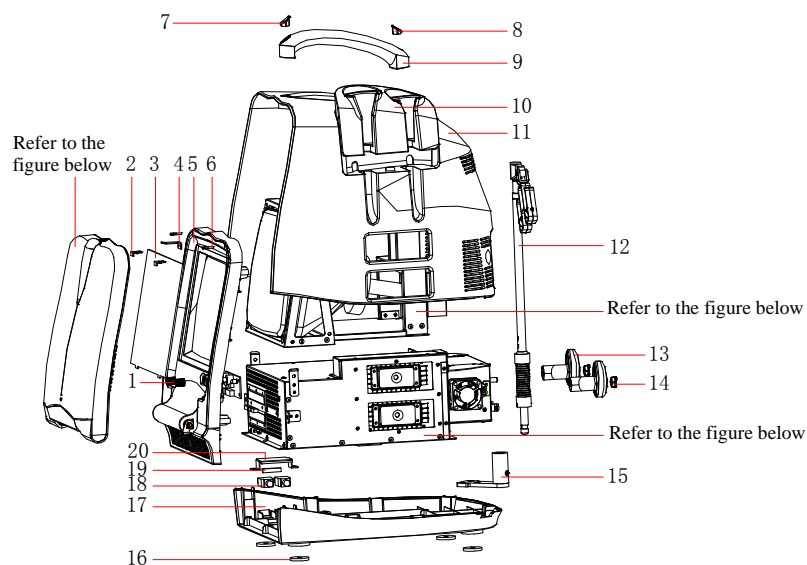


Figure 2-2 The exploded drawing of the complete machine

2.1.2.2. Parts of each assembly

1. CRT knob	2300-20-29084
2. screen filter fixing buckle	9901-20-23950
3. screen filter	2102-20-16994
4. keyboard hook	2300-20-29092
5. front cover	2300-20-29078
6. keyboard protective pad	2300-20-29091
7. handle rubber cap A	2300-20-29089
8. handle rubber cap B	2300-20-29090
9. handle	2300-20-29081
10. transducer holder	2300-20-29082
11. rear cover	2300-20-29079
12. transducer cable hook	2102-30-16949
13. winding rack	2300-20-29083
14. winding rack rubber cap	2300-20-29088
15. hook holder	2300-20-29085
16. bottom rubber pad	2300-20-29087
17. bottom plate	2300-20-29080
18. USB cable	2300-20-29138
19. conductive cloth	9901-10-23920
20. USB compressor	2300-20-29106

2.1.3. The keyboard assembly

2.1.3.1. The exploded drawing (1) of the keyboard assembly

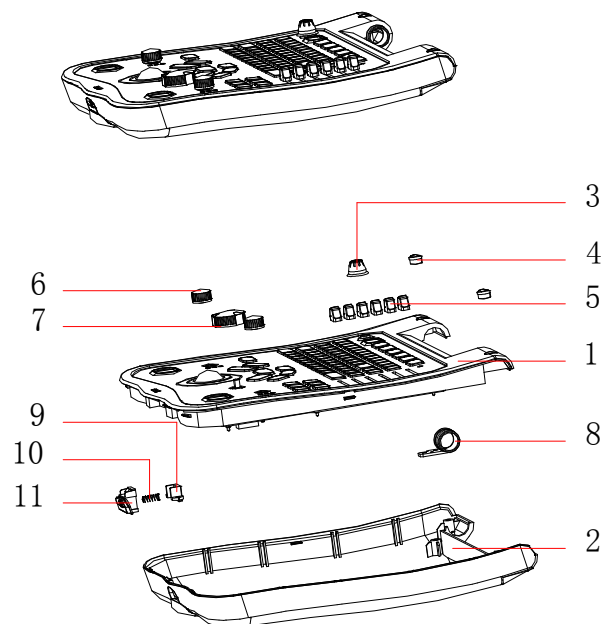


Figure 2-3 The exploded drawing (1) of the keyboard assembly

2.1.3.2. Parts of the keyboard assembly (1)

1. keyboard upper cover assembly	2300-30-29156
2. keyboard lower cover assembly	2300-30-29155
3. keyboard knob C	2300-20-29073
4. keyboard silicon cap	2300-20-29076
5. keyboard DIP switch	2300-20-29074
6. keyboard knob B	2300-20-29072
7. keyboard knob A	2300-20-29071
8. hollow shaft	2300-20-29067
9. position limiter	2300-20-29066
10. compressing spring	2300-20-29065
11. keyboard buckle	2300-20-29064

2.1.3.3. The exploded drawing (2) of the keyboard assembly

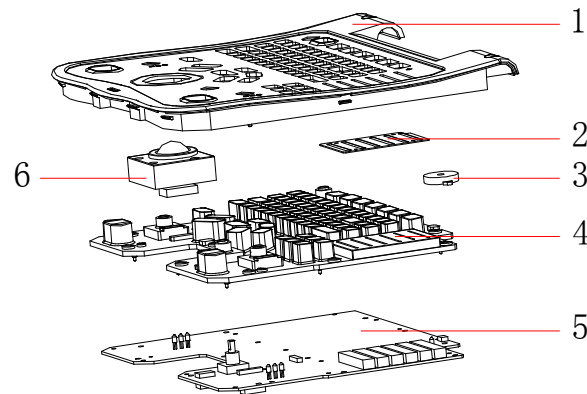


Figure 2-4 The exploded drawing (2) of the keyboard assembly

2.1.3.4. Parts of the keyboard assembly (2)

1. keyboard upper cover	2300-30-29156
2. dust plate	2300-20-29075
3. buzzer	2300-21-29142
4. silicon key	2300-20-29060
5. keyboard PCB board	2300-20-29057
6. trackball	0000-10-10893

2.1.4. The exploded drawing of CRT assembly

2.1.4.1. The exploded drawing of CRT assembly

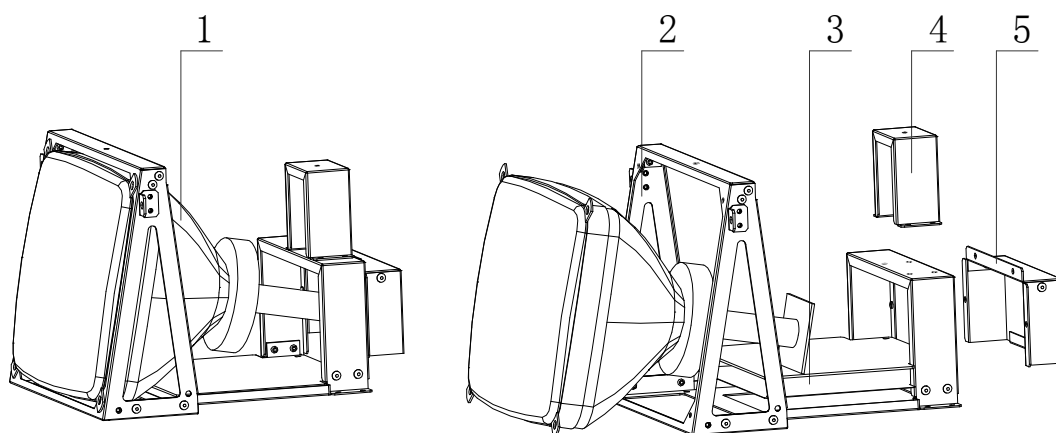


Figure 2-5 The exploded drawing of CRT assembly

2.1.4.2. Parts of CRT assembly

1.CRT assembly	2300-21-29149
2. CRT frame	2300-20-29094
3.CRT insulation pad	2300-20-29095
4. handle frame 2	2300-20-29108
5.guard plate	2300-20-29109

2.1.5. The power assembly

2.1.5.1. The exploded drawing of the power assembly

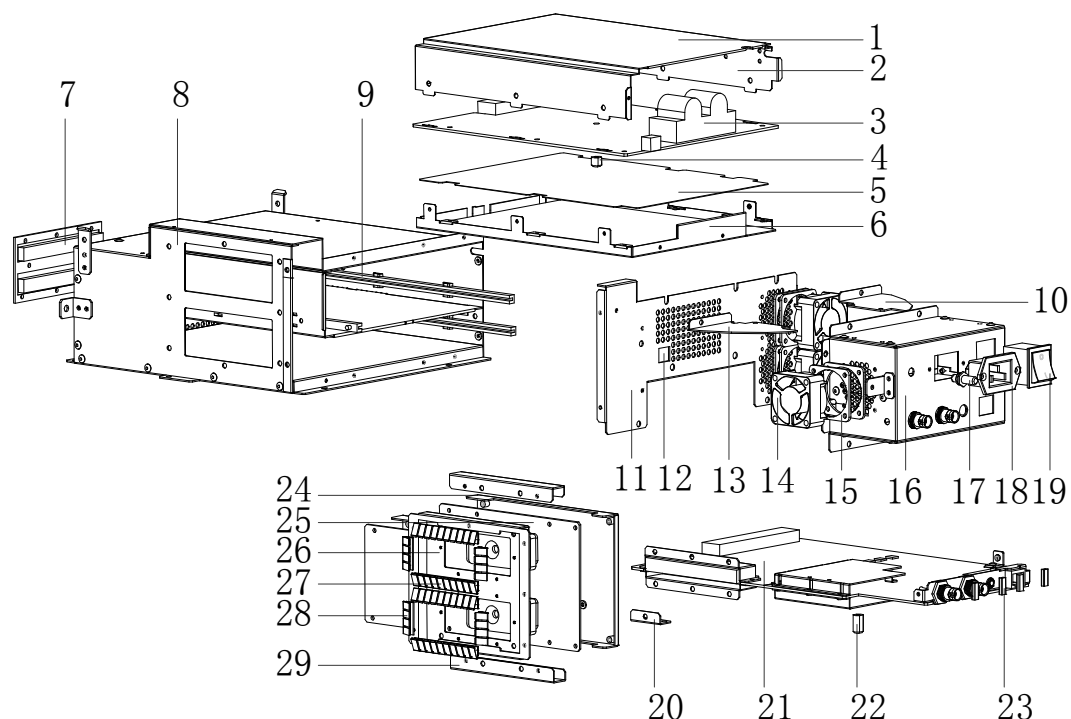


Figure 2-6 The exploded drawing of the power assembly

2.1.5.2. Parts of the power assembly

1. Power box upper cover	2300-20-29194	2. Fan connection wire	2300-20-29141
3. Power board	2300-30-29059	4. Power board support	2300-20-29098
5. Power box shielding pad	2300-20-29202	6. Power box lower cover	2300-20-29195
7.Connection board	2300-30-29053	8. Main unit cabinet	2300-20-29096
9. Plastic slot	M90-000115---	10. Right wind shield	2300-20-29113
11. Cabinet rear cover	2300-20-29104	12.Power connection wire	2300-20-29140
13.Left wind shield	2300-20-29107	14. Fan	2300-20-29143
15. Fan pad	2300-20-29099	16.Cabinet tail board	2300-20-29105

17. Grounding pole	0509-20-00098	18. Power socket	2300-21-29147
19. Power switch	2100-10-07943	20. Main board connector	2300-20-29208
21. Main board	2300-30-29051	22. Main board support	2300-20-29110
23. Conductive cloth	9901-10-23920		
24. Transducer board shield cover	2300-20-29198		
25. Transducer board	2300-30-29055		
26. Transducer socket fixed plate	2300-20-29101		
27. Shield spring A	2102-20-16918		
28. Shield spring B	2102-20-17113		
29. Transducer socket fastener	2300-20-29199		

2.2 Disassembly

2.2.1. Disassembly of the rear cover

1. Removing the transducer cable hook

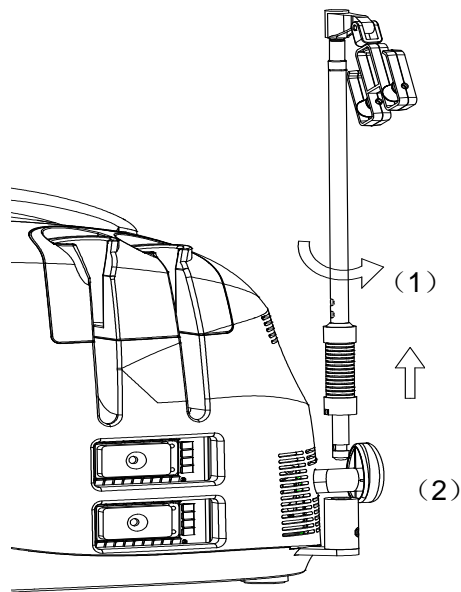


Figure 2-7 Disassembly of the rear cover

- A、 Turn the transducer cable hook clockwise to the end;
 - B、 Take out the transducer cable hook upward.
2. Removing the handle and winding rack

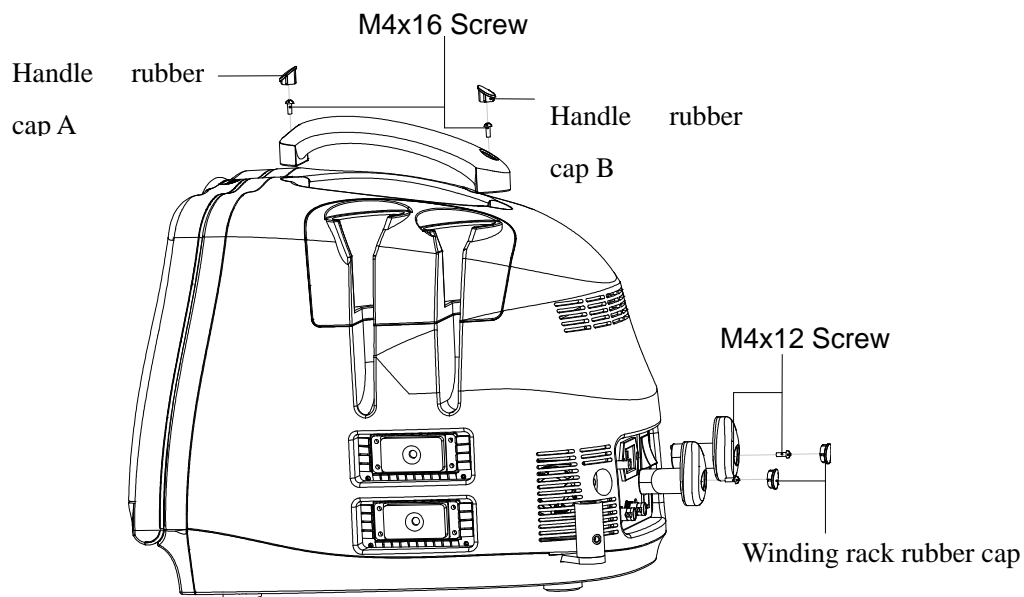


Figure 2-8 Removing the handle and winding rack

- A. Pull out the handle rubber cap A&B and the winding rack rubber cap;
 - B. Remove the two M4x16 fixing screws, and then take out the handle
 - C. Remove the two M4x12 fixing screws, and then take out the winding rack
3. Removing the rear cover

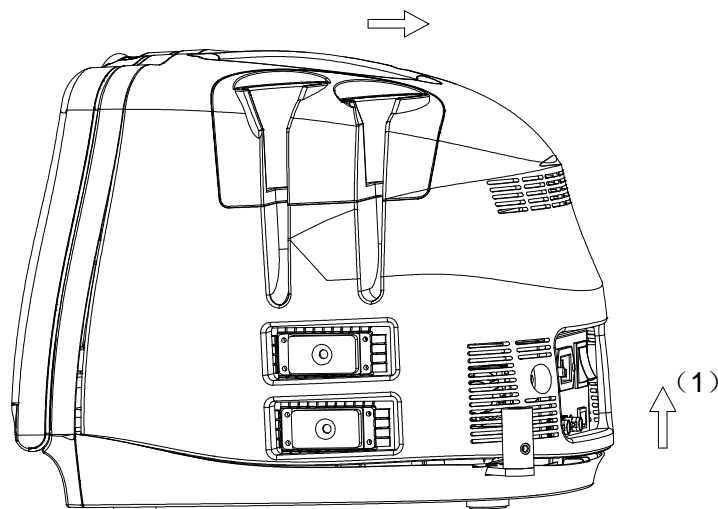


Figure 2-9 Removing the rear cover

- A. lift the tail of the rear cover forcibly;
- B. Move the rear cover backwards to remove it.

2.2.2. Disassembly of the cabinet tail board

1. Remove the rear cover;
2. Disconnect the fan connector of the tail board;
3. Remove 8 M3X6 screws fixing the tail board and 2 M3X6 screws fixing the main

board;

4. Disconnect the power wire connector and move the tail board backward to take it out.

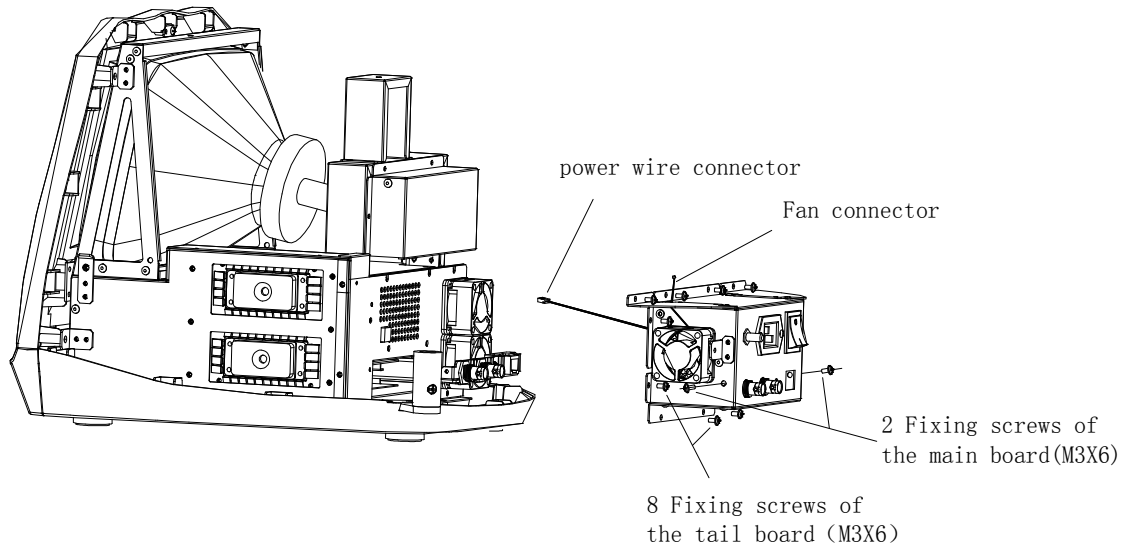


Figure 2-10 Disassembly of the cabinet tail board

2.2.3. Disassembly of the cabinet rear cover

1. Remove the assembly of the cabinet tail board;
2. Disconnect the fan connector of the rear cover;
3. Remove 9 M3X6 screws fixing the rear cover and take out the rear cover.

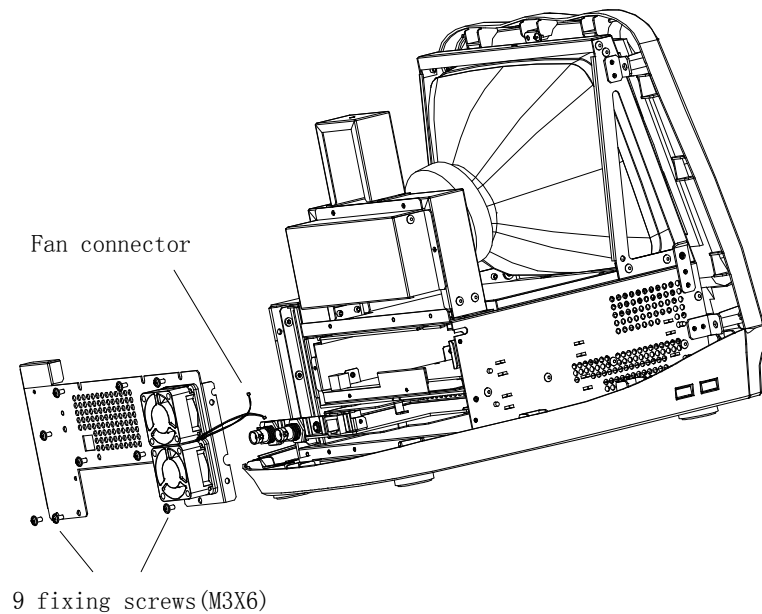


Figure 2-11 Disassembly of the cabinet rear cover

2.2.4. Disassembly of the power board

1. Remove the assembly of cabinet rear cover;
2. Pull out the assemble of the power board;

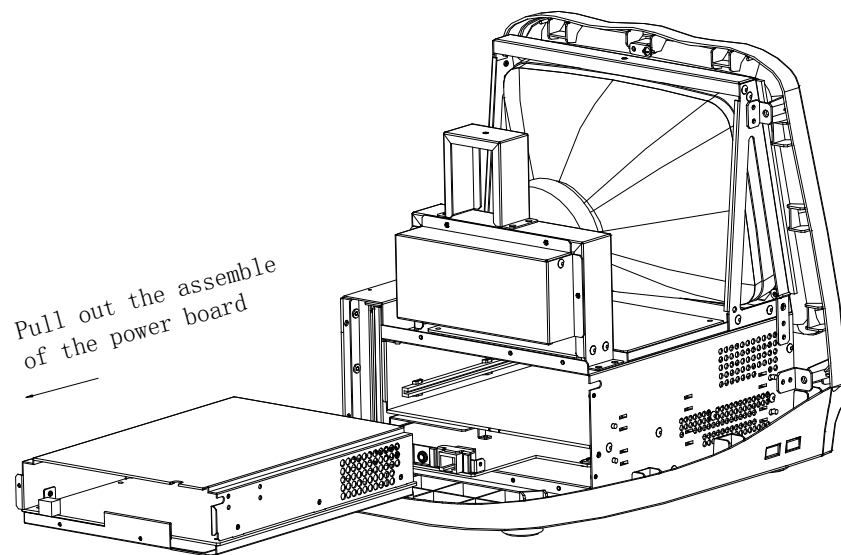


Figure 2-12 Disassembly of the power board

3. Remove 6 M3X6 screws fixing the power box upper cover, and open the upper cover;
4. Disconnect the fan connector of the power board;

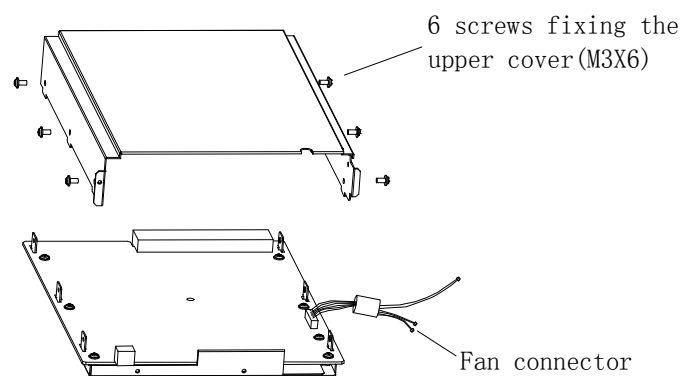


Figure 2-13 Disconnecting the fan connector

5. Remove 7 M3X8 screws fixing the power board and take out the power board;

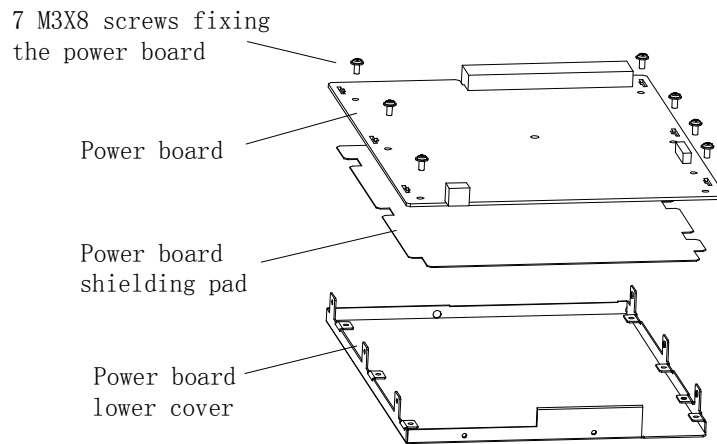


Figure2-14 Disassembly of the power board

2.2.5. Disassembly of the main board and the transducer board

1. Disassemble the rear cover to take out the assemblies of the tail board and the back board;
2. Remove 3 M3X8 screws fixing the holder of the transducer cable hook and take out the holder;

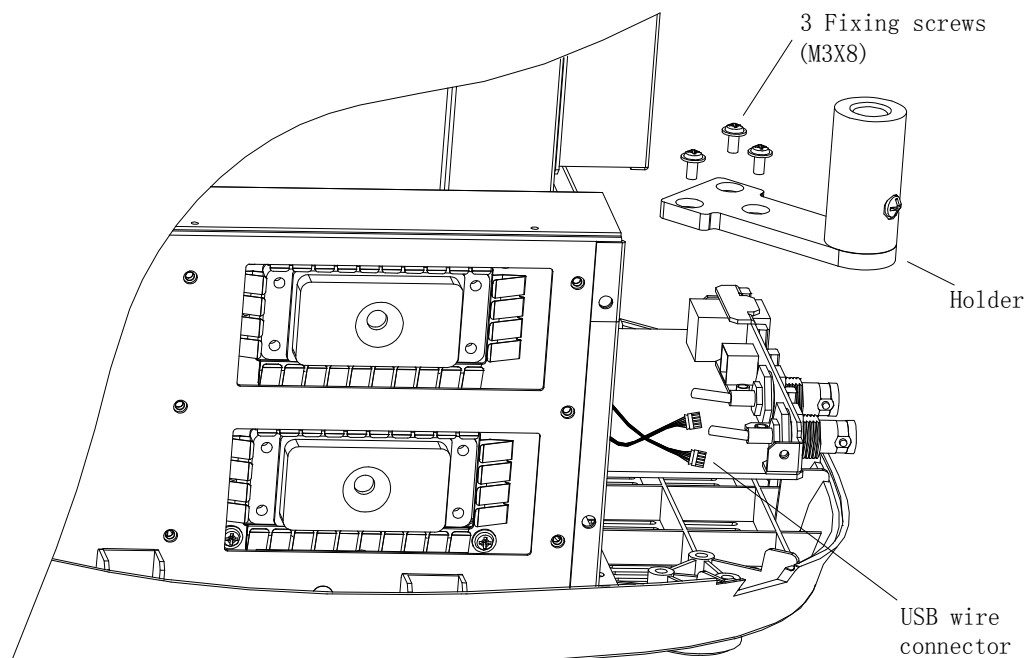


Figure 2-15 Remove the holder of the transducer cable hook

3. Remove the USB wire connector;

4. Remove 8 M3X6 screws fixing the holder and one M3X6 screw fixing the main board;

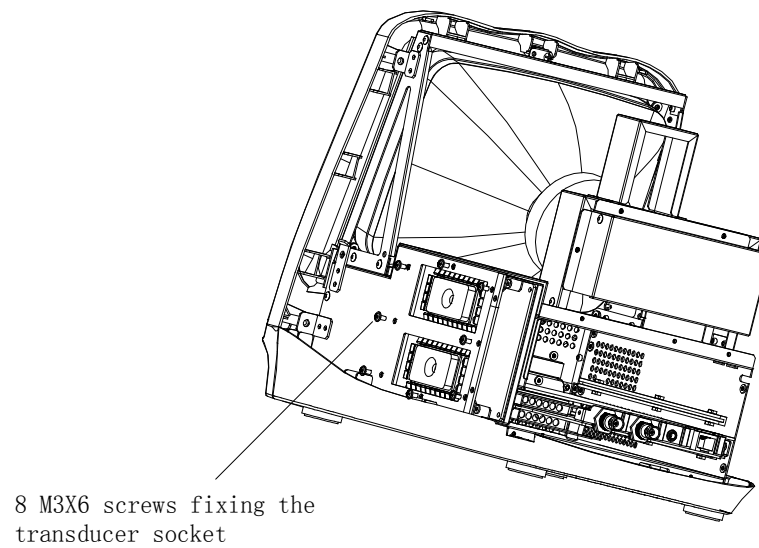


Figure 2-16 Disassembly of the main board and the transducer board (1)

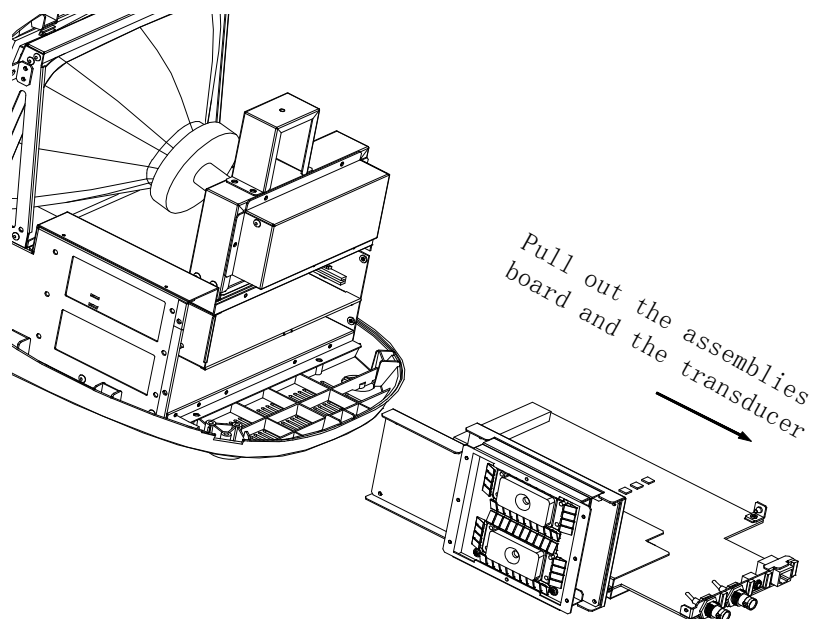


Figure 2-17 Disassembly of the main board and the transducer board (2)

5. Pull out the assemblies of the main board and the transducer board backward;

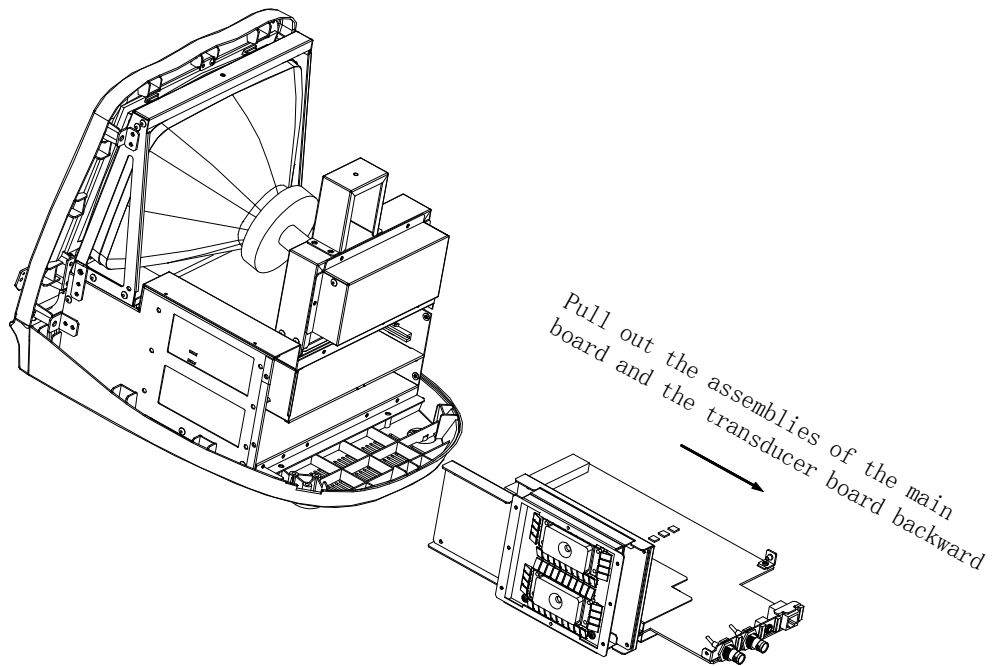


Figure 2-18 Disassembly of the main board and the transducer board (3)

6. Remove 7 M3X6 screws connecting the assemblies of the main board and the transducer board, and disassemble the main board;

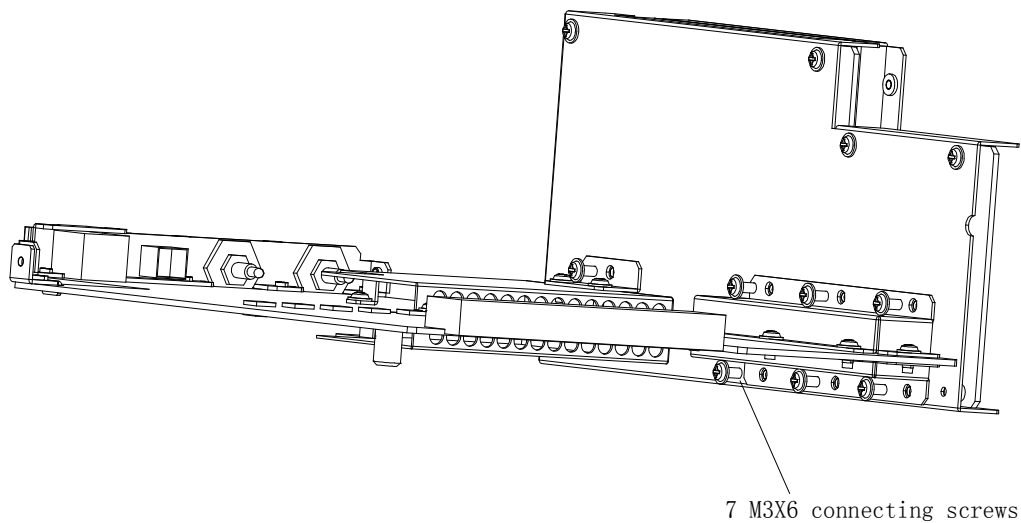


Figure 2-19 Disassembly of the main board and the transducer board (4)

7. Remove 8 M3X6 screws fixing the transducer board shield cover;

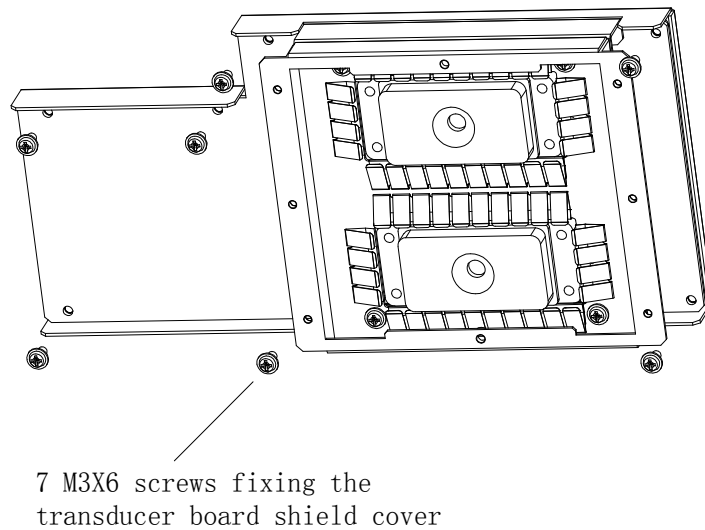


Figure 2-20 Disassembly of the main board and the transducer board (5)

8. Remove 4 M3X6 screws fixing the connection board of the transducer socket, and remove the transducer board;

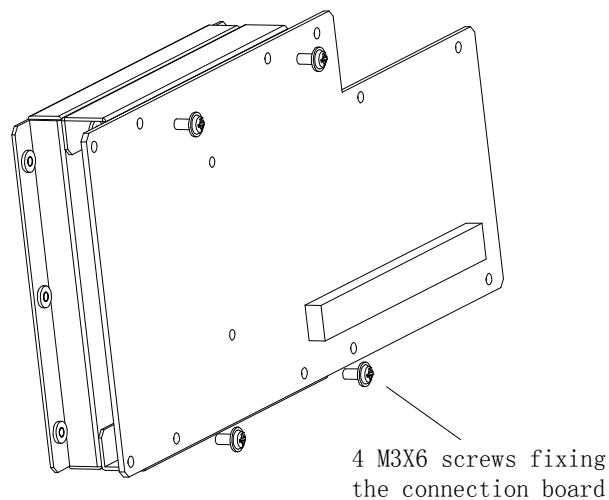


Figure 2-21 Disassembly of the main board and the transducer board (6)

2.2.6. Disassembly of CRT, CRT adjustment board and the connection board of the main unit

1. Disassemble the rear cover to take out the assemblies of the tail board and the back board;

2. Remove 4 PT4X14 screws fixing the front cover;

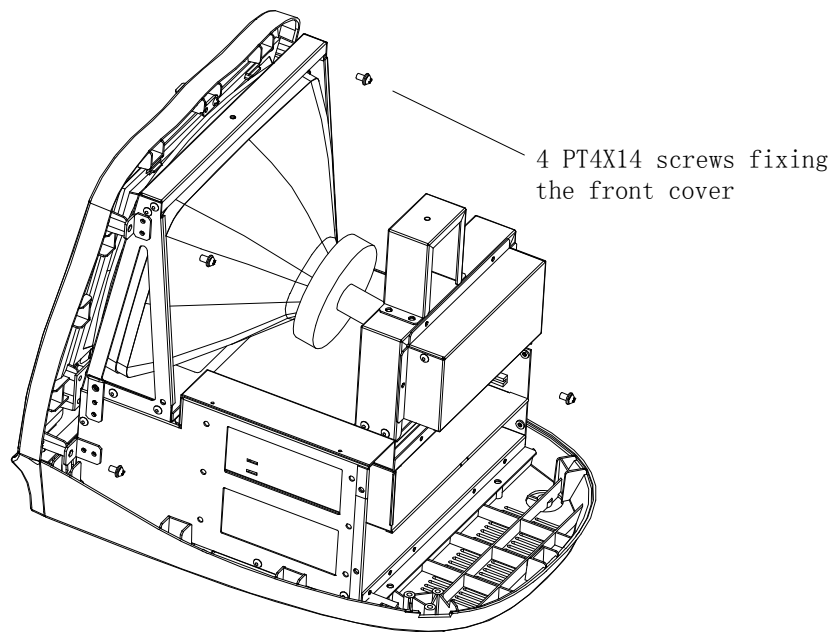


Figure 2-22 Remove 4 PT4X14 screws fixing the front cover

3. Disconnect CRT signal cable, keyboard connection wire, CRT power wire and CRT adjustment board connector;

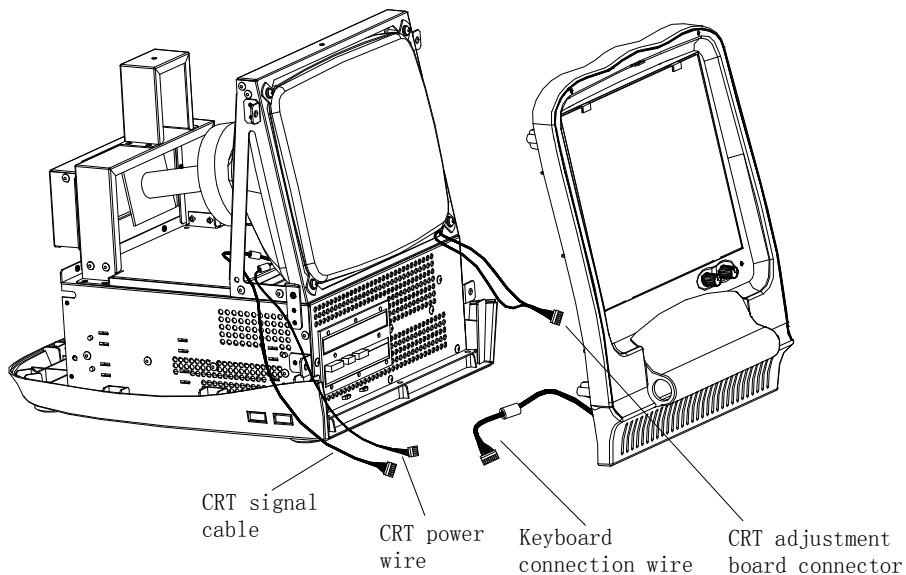


Figure 2-23 Disconnect the connection wires

4. Remove 8 M3X8 screws fixing CRT assembly and take out CRT;

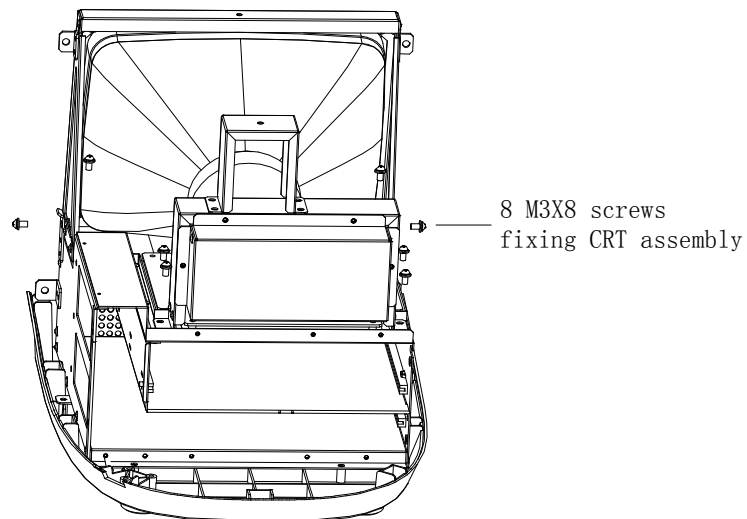


Figure 2-24 Remove CRT assembly

5. Remove CRT adjustment knobs and 4 PT3X8 screws fixing CRT adjustment board, and then remove the CRT adjustment board;

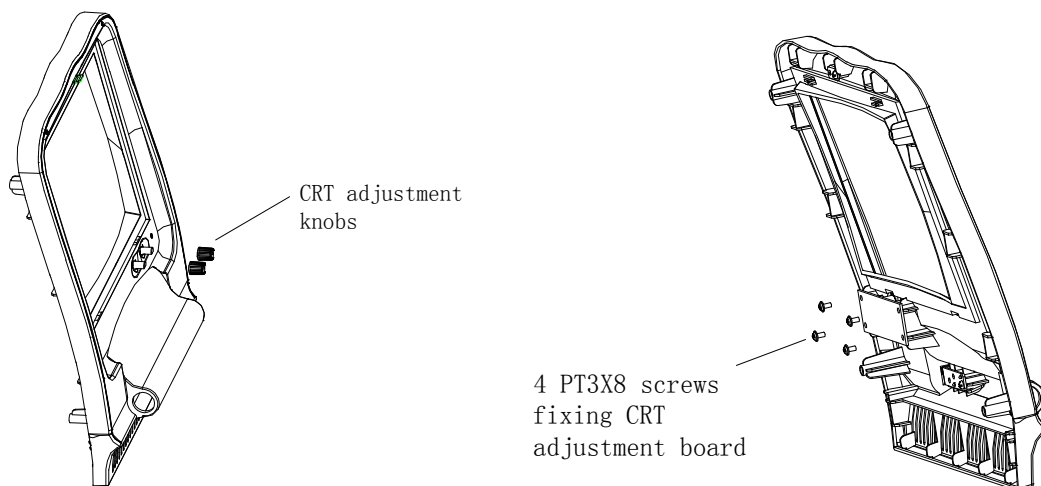


Figure 2-25 Remove CRT adjustment knobs

6. Remove 8 M3X6 screws fixing the connection board of the main unit, and then

remove the connection board of the main unit.

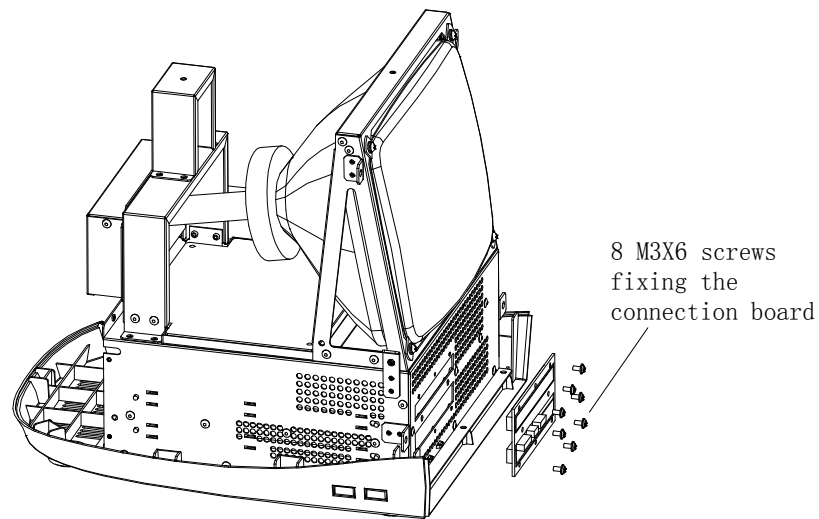


Figure 2-26 Remove the connection board of the main unit

2.2.7. Disassembly of CRT screen filter

1. Slide the two screen filter buckles outward and pull them out;
2. Pull out the upper screen filter outward and uplift it, and then take it out.

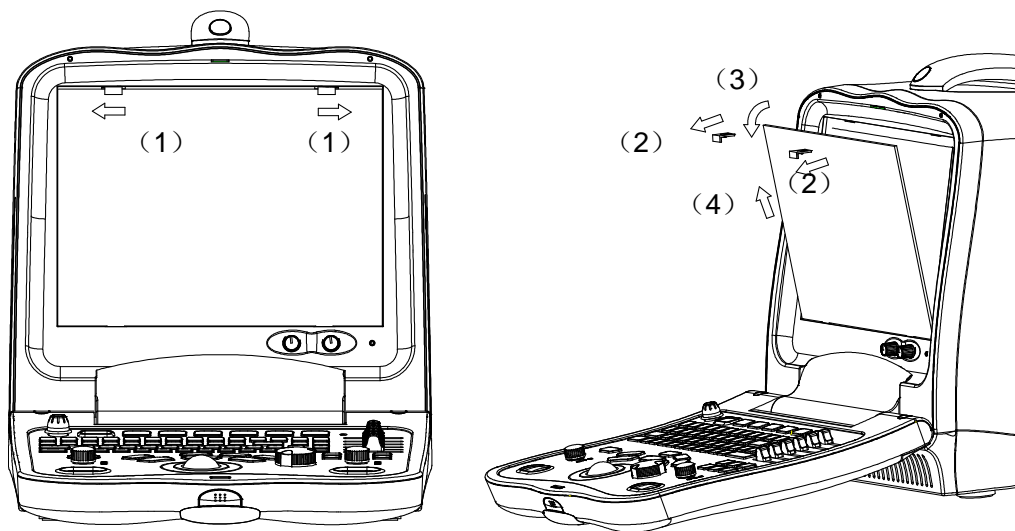


Figure 2-27 Disassembly of CRT screen filter

2.2.8. Disassembly of the keyboard, trackball and buzzer

1. Remove the two keyboard silicon caps, and then remove 2 M3×6 screws fixing the keyboard upper cover;

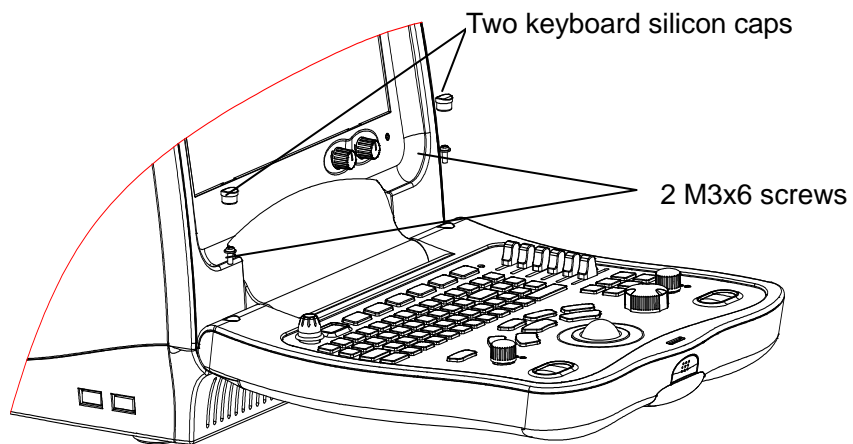


Figure 2-28 Remove the two keyboard silicon caps and two screws

2. Open the keyboard upper cover by hands forcibly at the positions of arrows;

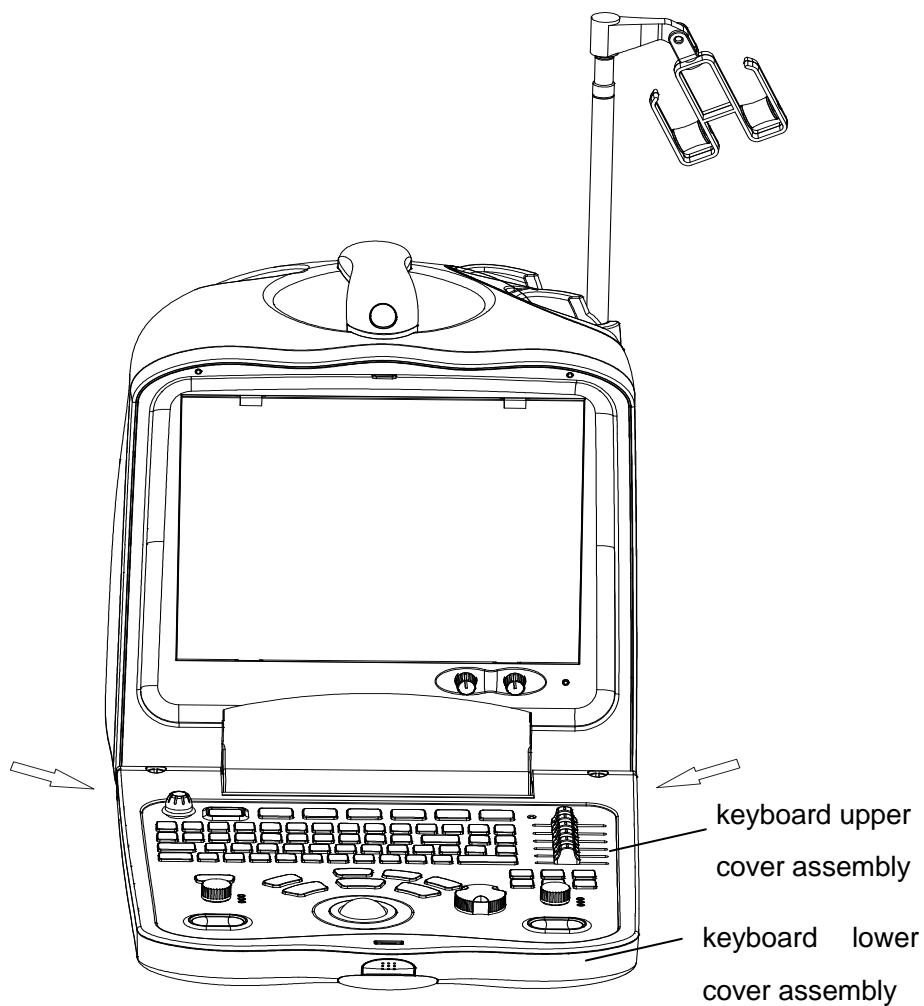


Figure 2-29 Disassembly of the keyboard upper cover

3. Disconnect the connection wire connector of the keyboard, and remove the keyboard upper cover;

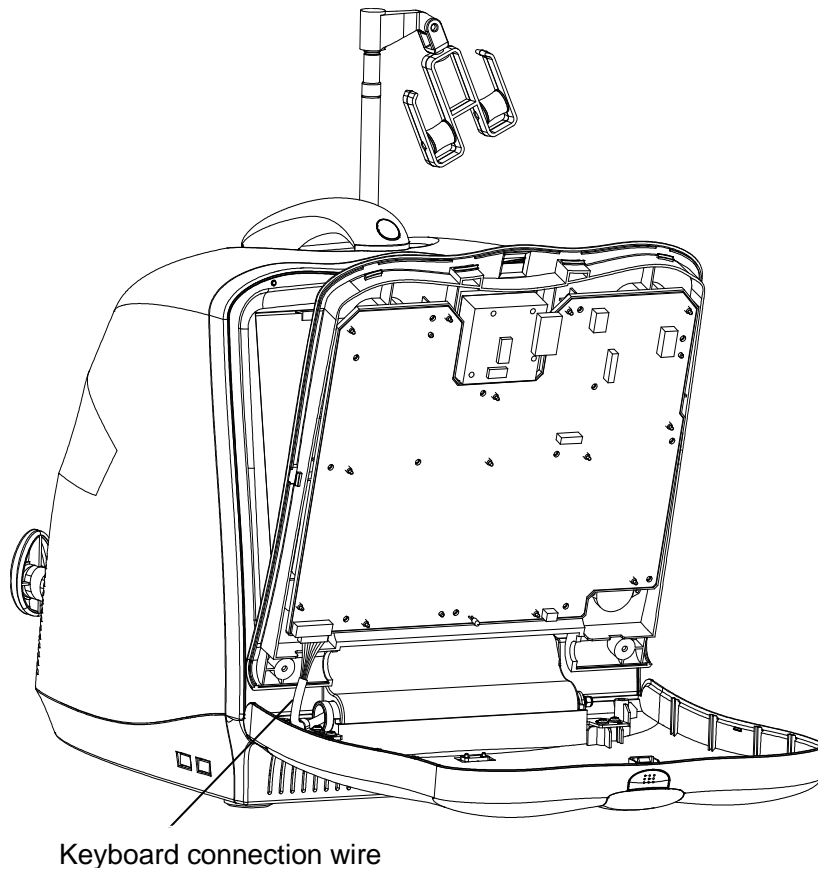


Figure 2-30 Disassembly of the keyboard upper cover

4. Disconnect the connection wire connector of the trackball, remove 4 self-threading ST3x14 screws fixing the trackball, and remove the trackball;

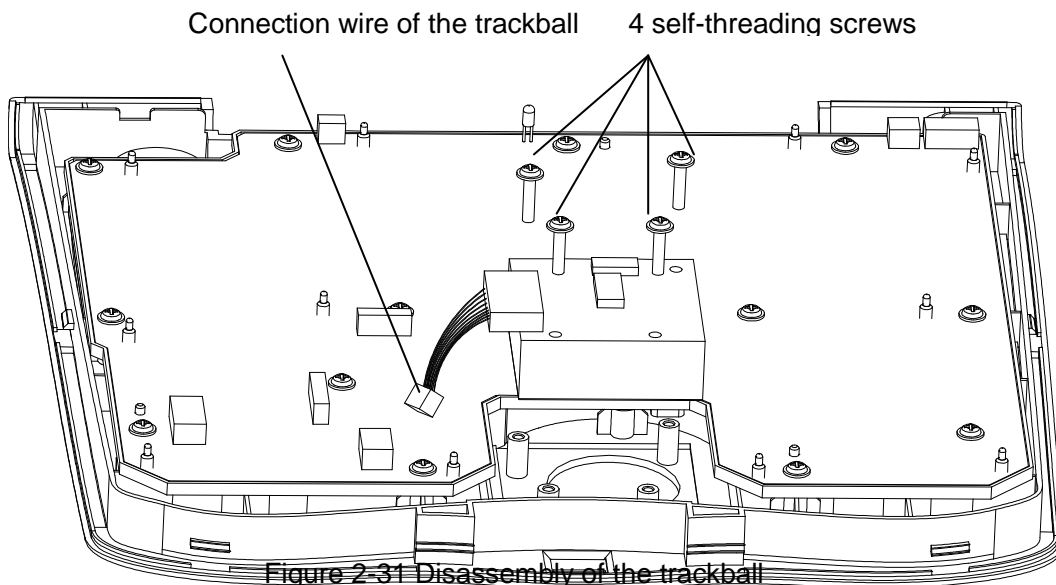


Figure 2-31 Disassembly of the trackball

5. Pull out keyboard knobs A, B, C and 6 keyboard DIP switches;

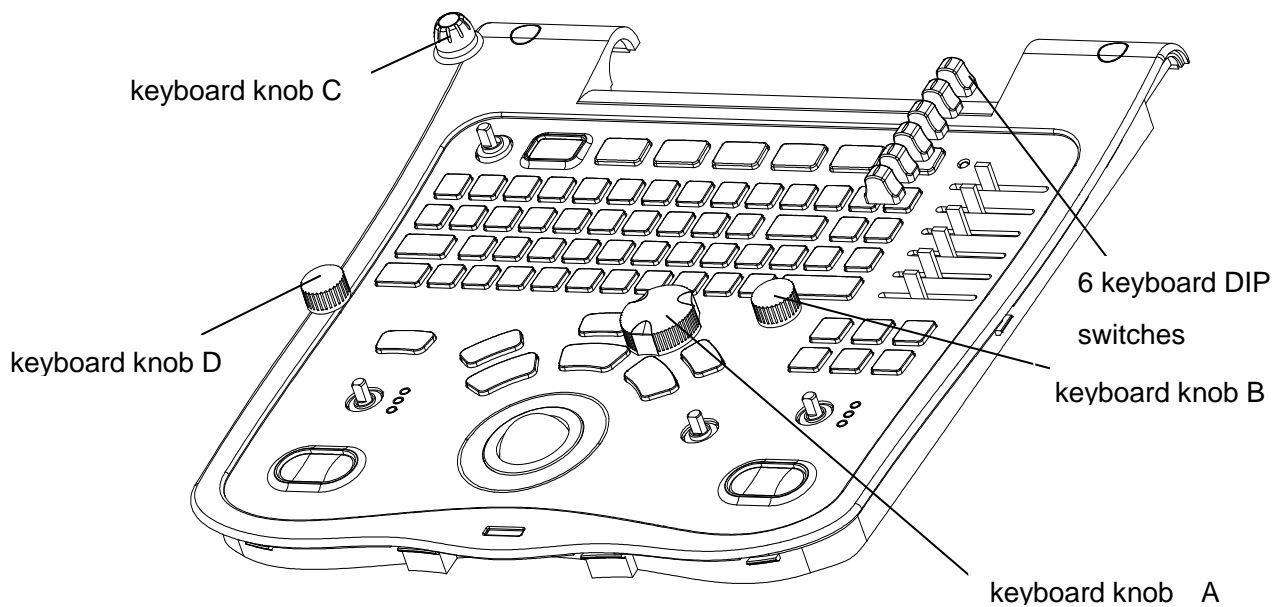


Figure 2-32 Remove the keyboard knobs and switches

6. Disconnect the connection wire connector of the buzzer, remove 14 ST3x8 screws fixing the keyboard, remove the silicon keys to take out keyboard PCB board, and remove 2 ST2x6 screws fixing the buzzer to take out the buzzer.

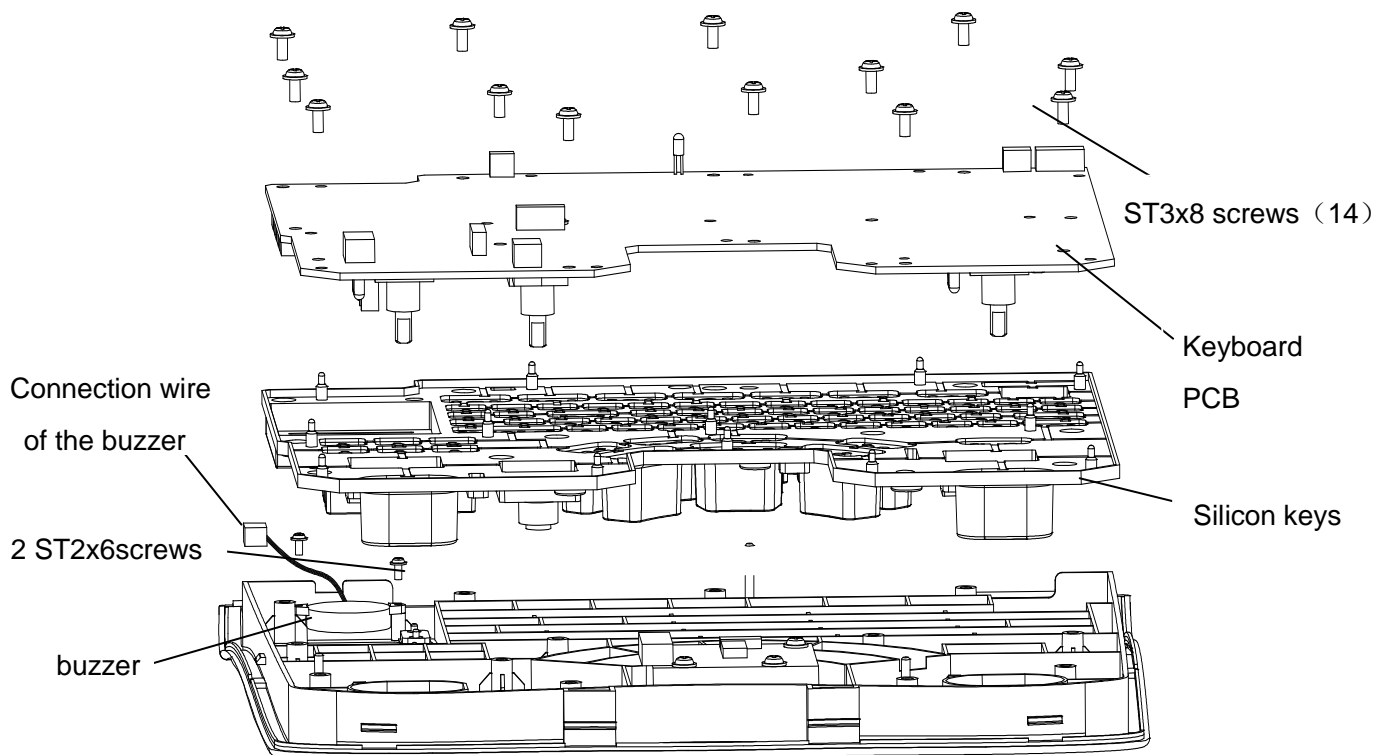


Figure 2-33 Remove the buzzer

2.2.9. Disassembly of the fan

1. Remove the rear cover;
2. Disconnect the tail board fan connector and remove 4 M3X30 screws, and then remove the tail board fan;

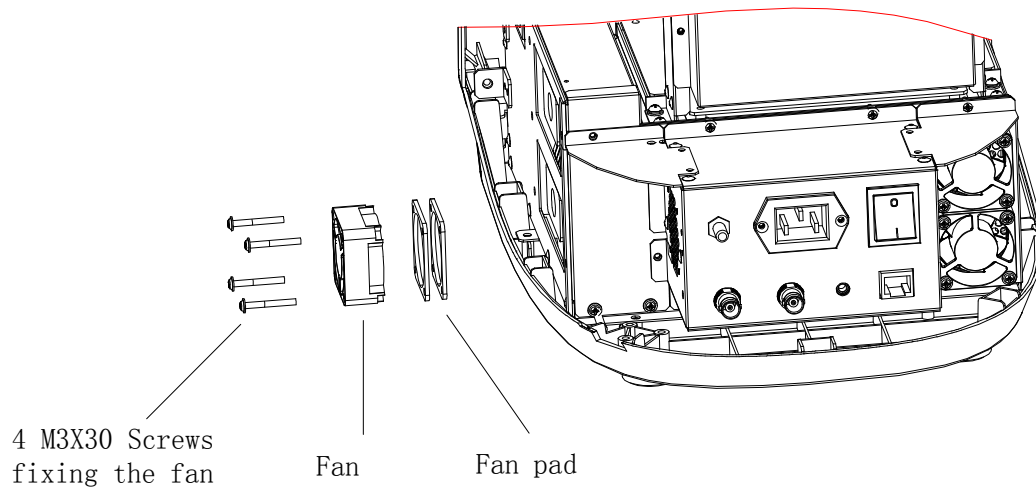


Figure 2-34 Disassembly of the tail board fan

3. Disconnect the back board fan connector and remove 8 M3X30 screws, and then remove the back board fan.

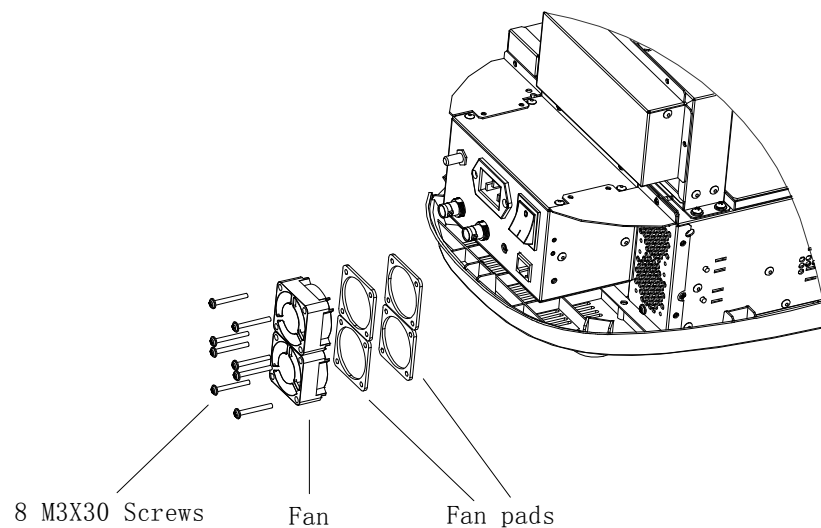


Figure 2-35 Disassembly of the back board fan

2.2.10. Remove USB extension wire

1. Disassemble the rear cover, the cabinet tail board assembly, the cabinet back board assembly and the front cover assembly;

2. Remove 7 PT3x8 screws fixing the cabinet bottom board, and remove the cabinet;

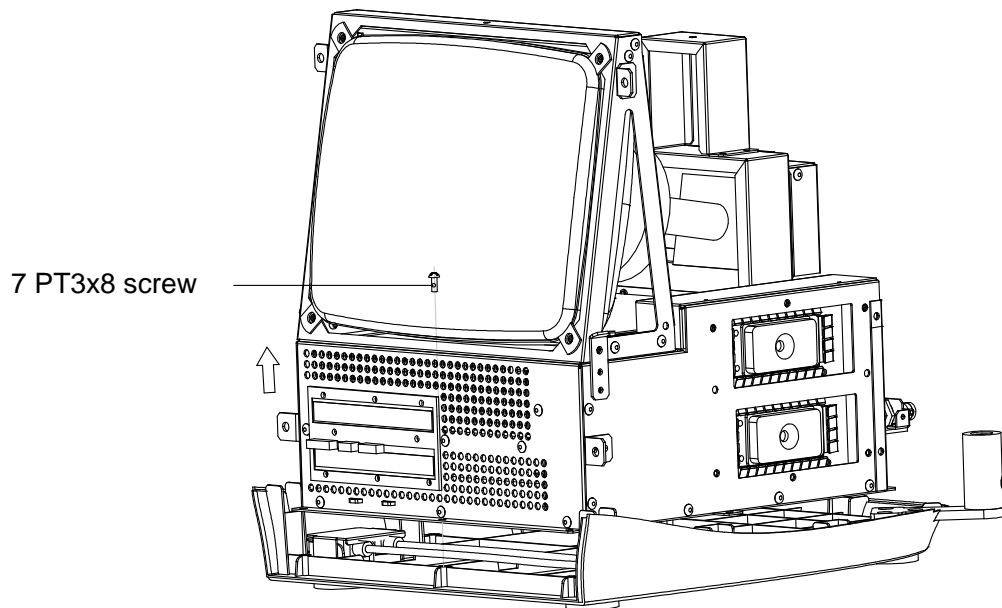


Figure 2-36 Disassemble the cabinet

3. Remove 2 PT3x 8 screws fixing USB compressor, and remove USB compressor, and then take out USB extension wire.

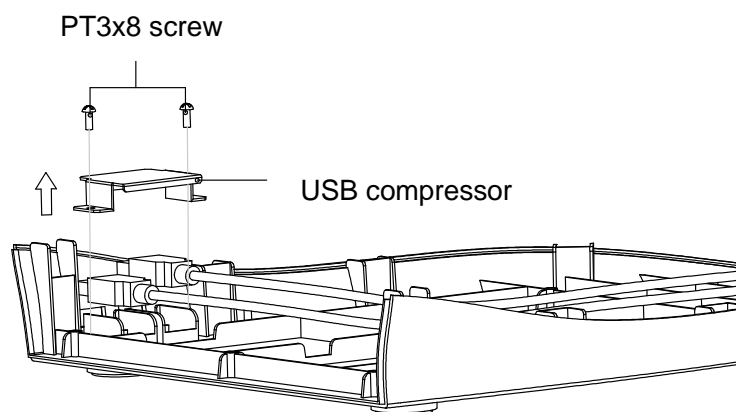


Figure 2-37 Remove USB extension wire

Chapter3 Description of the Principle

3.1 The Principle of the Hardware

3.1.1. The power board

3.1.1.1. Description of the power board

The power system is designed to supply power for the overall ultrasound diagnostic system, and it can supply nine static DC outputs, including the +5V (D+5V and A+5V) , -5V, +12V, +13.5V, +3.3V, +1.5V, +2.5V and program-controlled high voltage outputs.

The performance specifications for each output are shown in Table 3-1.

Table 3-1 the specifications for the power board outputs

Item	Rated Voltage (V)	Voltage Precision	Rated Load	Minimum Load	Voltage Adjustment Rate	Load Adjustment Rate	Ripple Noise (mV _{pk-pk})	Use
1	A+5V	±5%	3A	0.5A	<2%	<5%	<30mV	Analog circuits/keyboard
2	D+5V		3.5A	1.0A				Keyboard /USB
3	-5.0V		0.4A	20mA				Amplifier
4	+13.5V		1.5A	0.3A			<50mV	VGA
5	+12V		0.35A	100mA				Fan /CMOS devices
6	HV		50mA	0				Transmission circuit
7	+3.3V		3.5A	0.2A			<30mV	Digital circuits
8	+2.5V		1.0A	0.2A				Digital circuits
9	+1.5V		2.0A	0.2A				Digital circuits

3.1.1.2. The basic principle

The schematic diagram of the power board is shown in Figure 2-1.

As shown in the figure, the power board is comprised of the input circuit, PFC front

end, FORWARD converter and back stage DC-DC converter circuits. The AC input first goes through the EMI filter and surge suppression circuit, and then the BOOST APFC circuit to have the power factor corrected and to provide a stable 390V DC voltage to the FORWARD converter. The FORWARD converter provides 4 outputs, +5V, -5V, +13.5V and +24V. The 24V output serves as the input of the HV output of the power board. The +13.5V output passes two diodes to generate the +12V output of the power board. The +5V output serves two purposes: 1) to be divided into the A+5V and D+5V outputs of the power board; 2) to serve as the input to the back stage DC-DC converters to generate the +3.3V, +2.5V and +1.5V outputs of the power board.

The PFC circuit adopts the TI UC3854 as the control chip and incorporates the BOOST converter. The main switching transistor and free wheeling diode used are the IR IRFPC60LC and the FAIRCHILD ISL9RL1560G2, whose parameters are 600V/16A and 600V/15A respectively.

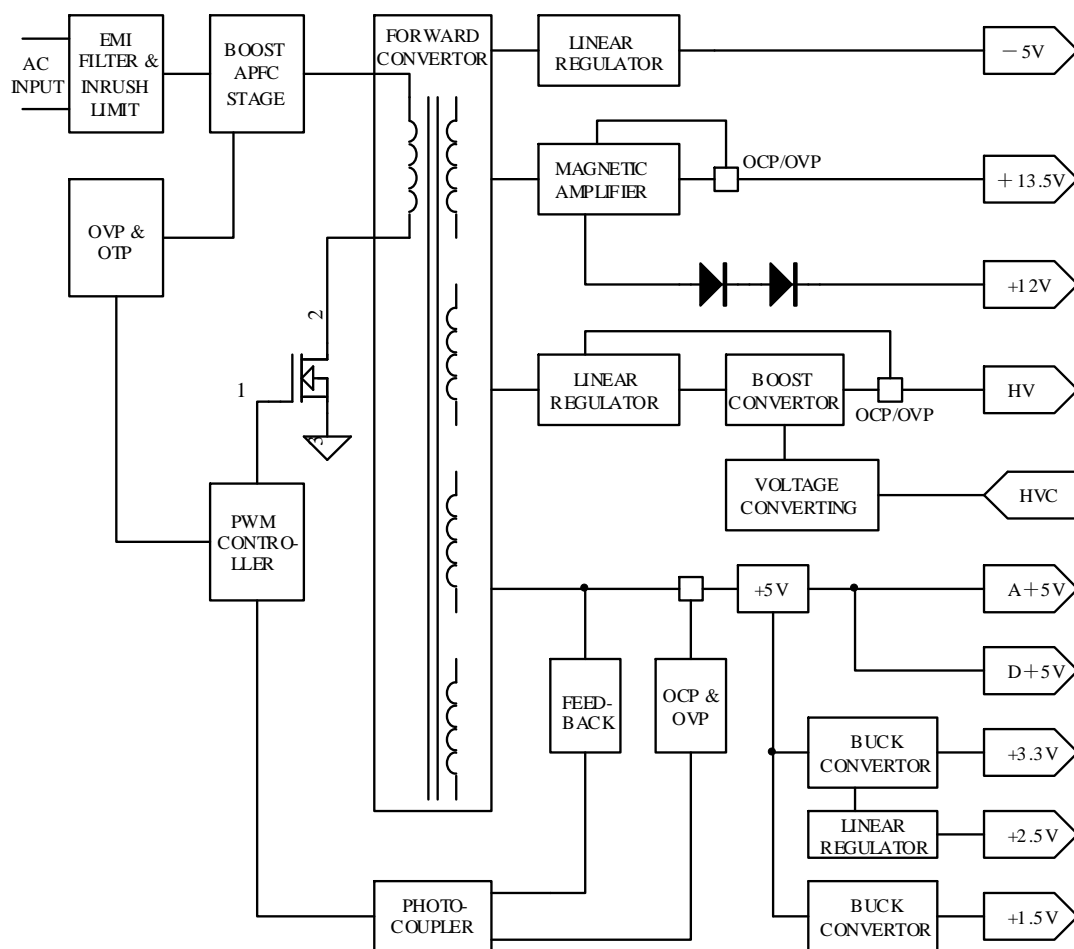


Figure 3-1 the schematic diagram of the power board

The FORWARD converter adopts the FUJITSU MB3769A as the control chip. The transformer T1 transforms the AC voltage into the DC voltage and isolates the former from the latter, making the system safe. The NEC 2SK2485 is used as the switching transistor, whose parameter is 900V/6A. The main feedback output of the FORWARD converter is +5V. The +13.5V output of the FORWARD converter is first stabilized by the magnetic amplifier and then serves as the +13.5V output of the power board. The -5V output of the FORWARD converter is first stabilized and then serves as the -5V output of the power board.

The BOOST converter, using the ON-SEMI TL594 as the control chip, converts the 24V output of the FORWARD converter into the HV output of the power board. An analog signal that varies between 0 to 4V controls the HV output, the latter varying linearly with the change of the former.

The BUCK converters, using the INTERSIL EL7566 as the control chips, are used to generate the +3.3V and +1.5V outputs of the power board. The +3.3V output is also passed to a linear stabilizer, which is composed of discrete devices, to generate the 2.5V output of the power board.

The power board features the over-voltage protection for the PFC output, the over-temperature protection, the over-voltage /over-current /short-circuit protection for the +5V output, the over-voltage /over-current /short-circuit protection for the +13.5V output, the over-voltage /over-current /short-circuit protection for the HV output, and the short-circuit protection for all other outputs. Once the protections are tripped, the power board reacts as follows:

1. When the over-voltage protection for the PFC output, over-temperature protection or the over-voltage /over-current /short-circuit protection for the +5V output is tripped, the power board cuts off all the outputs and keeps them locked. Only after the AC input is cut off and the fault is cleared and the system is reset, does the system return to normal work;
2. When the over-voltage /over-current /short-circuit protection for the +13.5V output is tripped, both the +13.5V output and the HV output are cut off and remain locked. After the fault is cleared and all loads are disconnected from the +13.5V output, both the outputs will resume;
3. When the short-circuit protection for the +3.3V output is tripped, both the +3.3V output and the HV output are cut off. After the fault is cleared, both the outputs will resume;

4. When the over-voltage /over-current /short-circuit protection for the HV output, over-current /short-circuit protection for the -5V output, short-circuit protection for the +1.5V output, or the over-current /short-circuit protection for +2.5V output is tripped, the faulty output will be cut off independently without affecting any normal output. After the fault is cleared, all the outputs return to normal work automatically, except the HV output remains locked.

3.1.1.3. Maintenance of the power board

Before tested, the power board should be connected as per Figure3-2. In the figure, the load A is a must, while the load B depends on situations. Under some conditions, for the purpose of easy repair, the load B is not allowed to exceed 0.1A, and it should be applied only when other outputs are minimum.

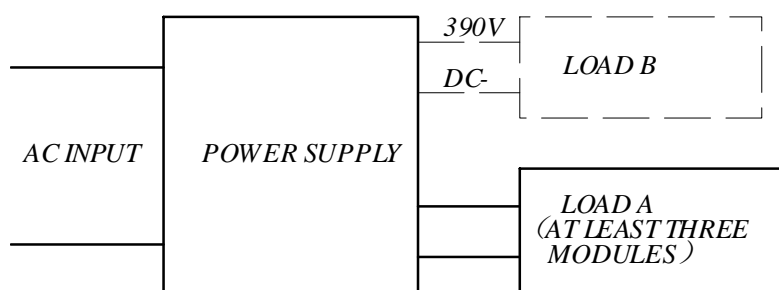


Figure 3-2 Connection schematic of the power board for testing

Based on your own needs, you can connect the loads only to the +5V, +13.5V and HV outputs. For the purpose of easy adjustment, it is recommended that the adjustment starts with a load slightly greater than the minimum load, and the load can be increased according to practical situations during adjustment.

After the power board is correctly connected, follow the flow chart indicated in Figure3-3 to find and fix the faults.

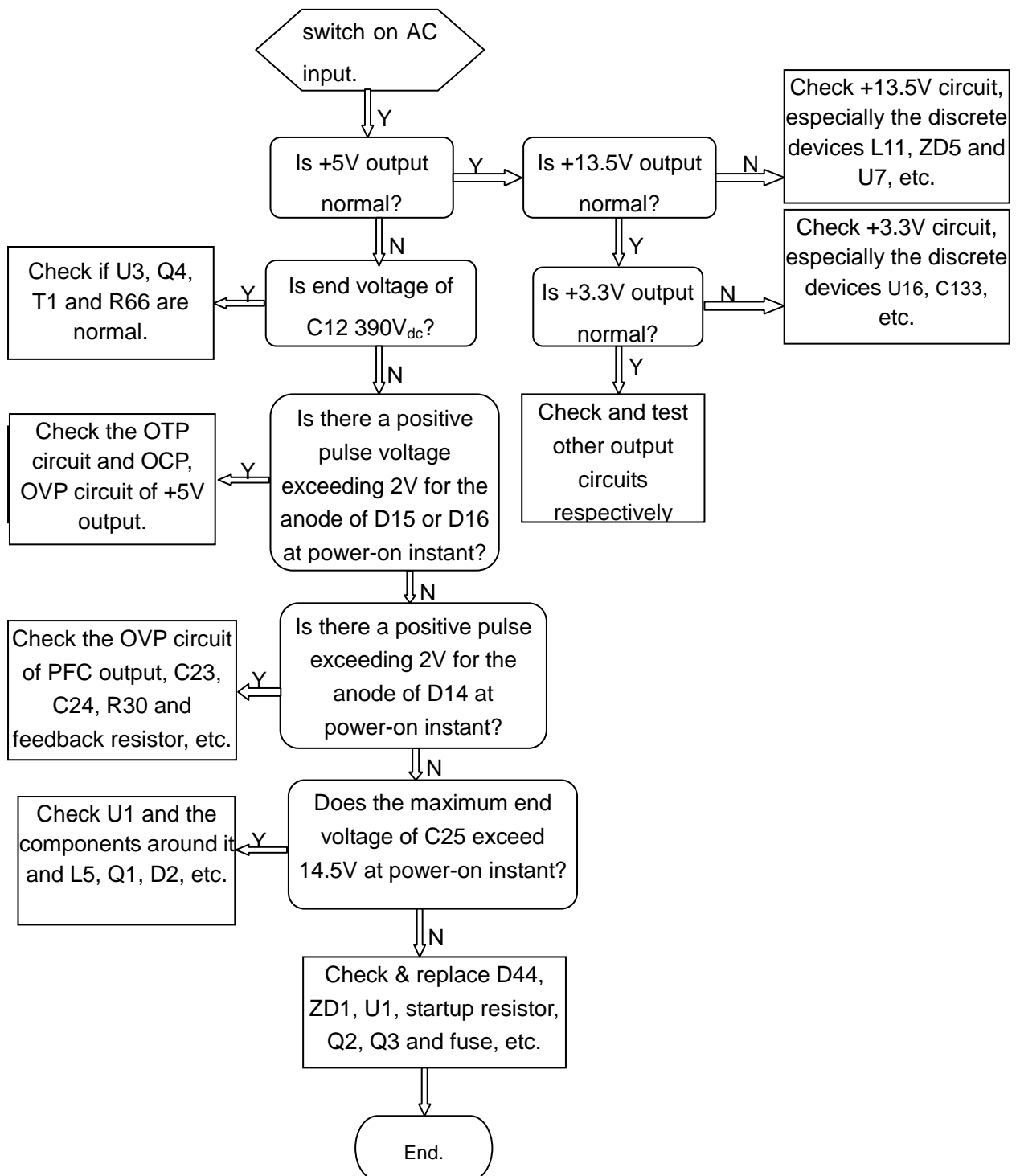


Figure 3-3 Trouble-shooting flow chart for the power board

3.1.2. The connection board

The connection board is designed for connecting the main board, power board, keyboard and monitor. See Figure 3-4 for the connections.

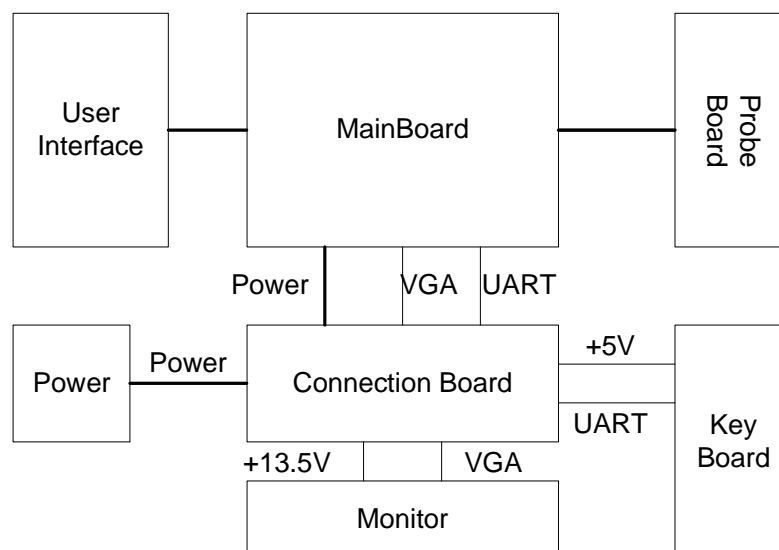


Figure 3-4 Interconnection of the system

The signals of the connection board are defined as follows:

Table 3-2 Definition of the connection board signals

Symbol	Name	Description
NC	Empty	No connection
GND	Ground	Ground, not specified as the analog or digital ground.
PHV	High voltage pulse	The HV output of the power board, ranging from +30V to +140V.
13V5	+13.5V power	The +13.5V output of the power board.
12V	+12V power	The +12V output of the power board.
A+5	+5V analogue power	The A+5V output of the power board.
D+5	+5V digital power	The D+5V output of the power board.
3V3	+3.3V power	The +3.3V output of the power board.
2V5	+2.5V power	The +2.5V output of the power board.
1V5	+1.5V power	The +1.5V output of the power board.
-5V	-5V power	The -5V output of the power board.
HVC	High voltage control	The analog signal that goes from the main board to the power board to control the HV output and varies between 0 and 4V.
RxDFromKB	Receive data	The 5V TTL serial signal from the keyboard to the main

	from keyboard	board.
TxDToKB	Transmit data to keyboard	The 5V TTL serial signal from the main board to the keyboard.
VS	VGA vertical synchronization	The 3.3V COMS signal from the main board to the monitor for VGA vertical synchronization.
HS	VGA horizontal synchronization	The 3.3V COMS signal from the main board to the monitor for VGA horizontal synchronization.
B	VGA video signal	The analog video signal from the main board to the VGA port of the monitor, the maximum value up to 0.7V.

A VME socket, the AMP AMP535043-4, is used for connecting the main board and the connection board. The main board is connected with the power board through the connection board, to obtain the powers PHV, -5V, A+5V, 2.5V, 1.5V, 3.3V, 12V, 13.5V and D+5V digital. The main board outputs an analog signal, HVC, to control the HV output of the power board. The serial signals RxDFromKB and TxDToKB are used for the communications between the main board and keyboard. The main board outputs the VGA signals HS, VS and B to the monitor. See Table 3-3 Definition of the interface signals between the main board and the connection board below:

Table 3-4 Definition of the interface signals between the main board and the connection board

	A	B	C
1	PHV	PHV	PHV
2	NC	NC	NC
3	GND	GND	GND
4	-5V	-5V	-5V
5	GND	GND	GND
6	12V	12V	12V
7	GND	GND	GND
8	A+5	A+5	A+5
9	A+5	A+5	A+5
10	A+5	A+5	A+5
11	GND	GND	GND
12	HVC	GND	GND
13	GND	GND	GND
14	GND	GND	GND
15	2V5	2V5	2V5

16	GND	GND	GND
17	1V5	1V5	1V5
18	1V5	1V5	1V5
19	GND	GND	GND
20	GND	GND	GND
21	3V3	3V3	3V3
22	3V3	3V3	3V3
23	GND	GND	GND
24	GND	GND	GND
25	13V5	13V5	13V5
26	VS	GND	GND
27	HS	GND	B
28	GND	GND	GND
29	TxDToKB	GND	RxDFromKB
30	GND	GND	GND
31	D+5	D+5	D+5
32	D+5	D+5	D+5

Another VME socket, also the AMP AMP535043-4, is used for connecting the power board and the connection board. See Table 3-4 for the definition of the interface signals:

Table 3-4 Definition of the interface signals between the power board and the connection board

	A	B	C
1	PHV	PHV	PHV
2	NC	NC	NC
3	GND	GND	GND
4	-5V	-5V	-5V
5	GND	GND	GND
6	12V	12V	12V
7	GND	GND	GND
8	A+5	A+5	A+5
9	A+5	A+5	A+5
10	A+5	A+5	A+5
11	GND	GND	GND
12	HVC	GND	GND
13	GND	GND	GND

14	GND	GND	GND
15	2V5	2V5	2V5
16	GND	GND	GND
17	1V5	1V5	1V5
18	1V5	1V5	1V5
19	GND	GND	GND
20	GND	GND	GND
21	3V3	3V3	3V3
22	3V3	3V3	3V3
23	GND	GND	GND
24	GND	GND	GND
25	13V5	13V5	13V5
26	NC	GND	GND
27	NC	GND	NC
28	GND	GND	GND
29	NC	GND	NC
30	GND	GND	GND
31	D+5	D+5	D+5
32	D+5	D+5	D+5

The B8B-PH-K-S made by JST is used for connecting the keyboard and the connection board, and the interface signals between the two boards are defined in the table below. The serial communication signals between the keyboard and the main board are switched through the connection board, with TTL level and baud rate 38400bps; the +5V power of the keyboard is the D+5V output of the power board, and its current is 2A.

Table 3-5 Definition of the interface signals between the keyboard and the connection board

Position	PIN1	PIN2	PIN3	PIN4	PIN5	PIN 6	PIN7	PIN8
Signal	RxDFromKB	GND	TxDToKB	GND	GND	GN D	D+5	D+5
Description	From keyboard to main board	Ground	From main board to keyboard	Ground			+5V power	

The signals transmitted from the main board to the monitor are switched through the connection board. The horizontal synchronization signal HS and the vertical

synchronization signal VS feature 3.3V CMOS, vertical scan frequency 60Hz, horizontal scan frequency 31.5KHz and non-interlaced scanning. The video signal is obtained from the B of RGB, and it is a monochromatic signal that features over 40MHz bandwidth, 75 Ω input impedance, 0.7V maximum amplitude. Since the B is the analogue video signal, which shouldn't be interfered by digital signals, the ground wire must be used for shielding. The signal wire from the monitor is connected to the JST B6B-PH-K-S socket on the connection board. See Table 3-6 for the definition of the interface signals.

Table 3-6 Definition of the socket of the display signal

Position	PIN1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6
Signal	GND	HS	VS	GND	GND	B
Description	Ground	Horizontal synchronization	Vertical synchronization	Ground	Ground	Video signal

The monitor obtains the +13.5V power, the current of which is 1.5A, from the 13.5V output of the power board. The power cable of the monitor is connected to the JST B4B-PH-K-S socket on the connection board. See Table 3-7 for the definition of the interface signals.

Table 3-7 Definition of the power socket of the monitor

Position	PIN 1	PIN 2	PIN 3	PIN 4
Signal	GND	GND	13V5	13V5
Description	Ground		13.5V power	

3.1.3. The transducer board

The transducer board is designed to switch between the two transducers and to read the ID code from the corresponding transducer. Relay channels are incorporated to control the switch, while they are driven by another two relays. The control signal ENB from the main board, used as the coordinating signal of the transducer board, controls the 2N7002LT1(an N-type FET) and the MC74HCT244(an IC component). The FET controls the relays to switch the transducers, while the MC74HCT244 returns the correct ID code to the corresponding data interface for the main board to read it out.

The schematic diagram of the transducer board is shown in the figure below:

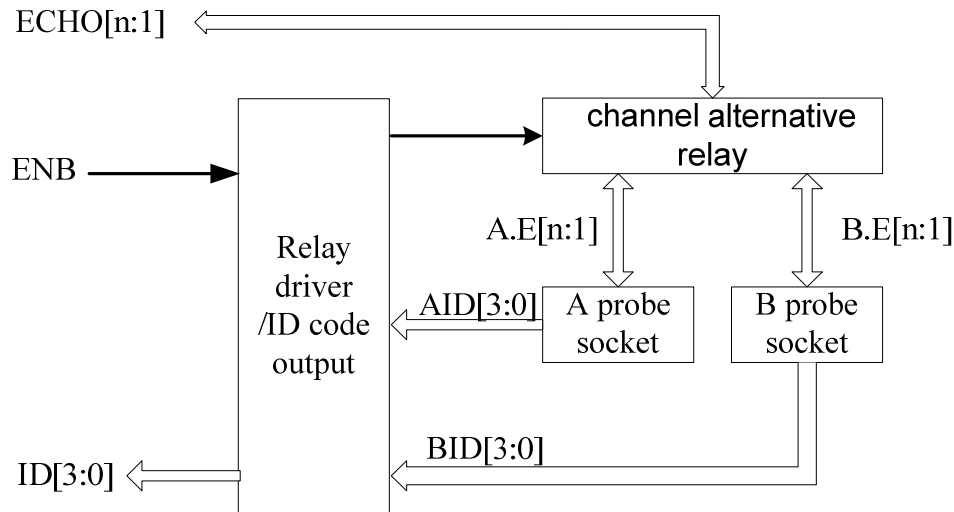


Figure 3-5 the schematic diagram of the transducer board

3.1.4. The main board

3.1.4.1. Principle description

The main board can realize the functions such as transmission and reception, beam forming, signal processing, DSC, CINE review, networking, USB, VIDEO and VGA, etc.

The hardware of the main board supports an transmission circuit, which is divided into an low-voltage transmission pulse drive circuit and high-voltage transmission pulse drive circuit. The transmission is realized by the EP1S10 (FPGA of Stratix series), and its sequence is controlled by the FPGA as well.

The ATGC-DAC circuit mainly uses the DAC to generate the voltage-controlled signal of the voltage-controlled gain amplifier. In addition, this dual-channel DAC can also generate a voltage-controlled signal for controlling the PHV variation, and the input signal of the DAC is provided by EP1S10.

EP1S10F672C7 is the FPGA of the Stratix series made by ALTERA. It features 1M gate, 10,000 LE, 94 512bits RAM blocks, 60 4Kbits RAM blocks, one 512Kbits RAM block, and six DSP blocks(each DSP block can be configured into one 36×36 multiplier, four 18×18 multipliers or eight 9×9 multipliers). It also supports various 3.3V differential I/Os and DDR interface. In the DP-6600, EP1S10F672C7 is the control core for the front end circuit, providing the transmission sequence control of the transmission circuit, the control of the reception selection circuit, the gain adjustment control of the voltage controlled gain amplifier, the adjustment control of PHV, the beam forming logic, the signal processing logic. Moreover, the

phase lock loop output of EP1S10F672C7 provides a 29.5MHz clock for PAL system VIDEO signal and a 6MHz clock for USB control chip.

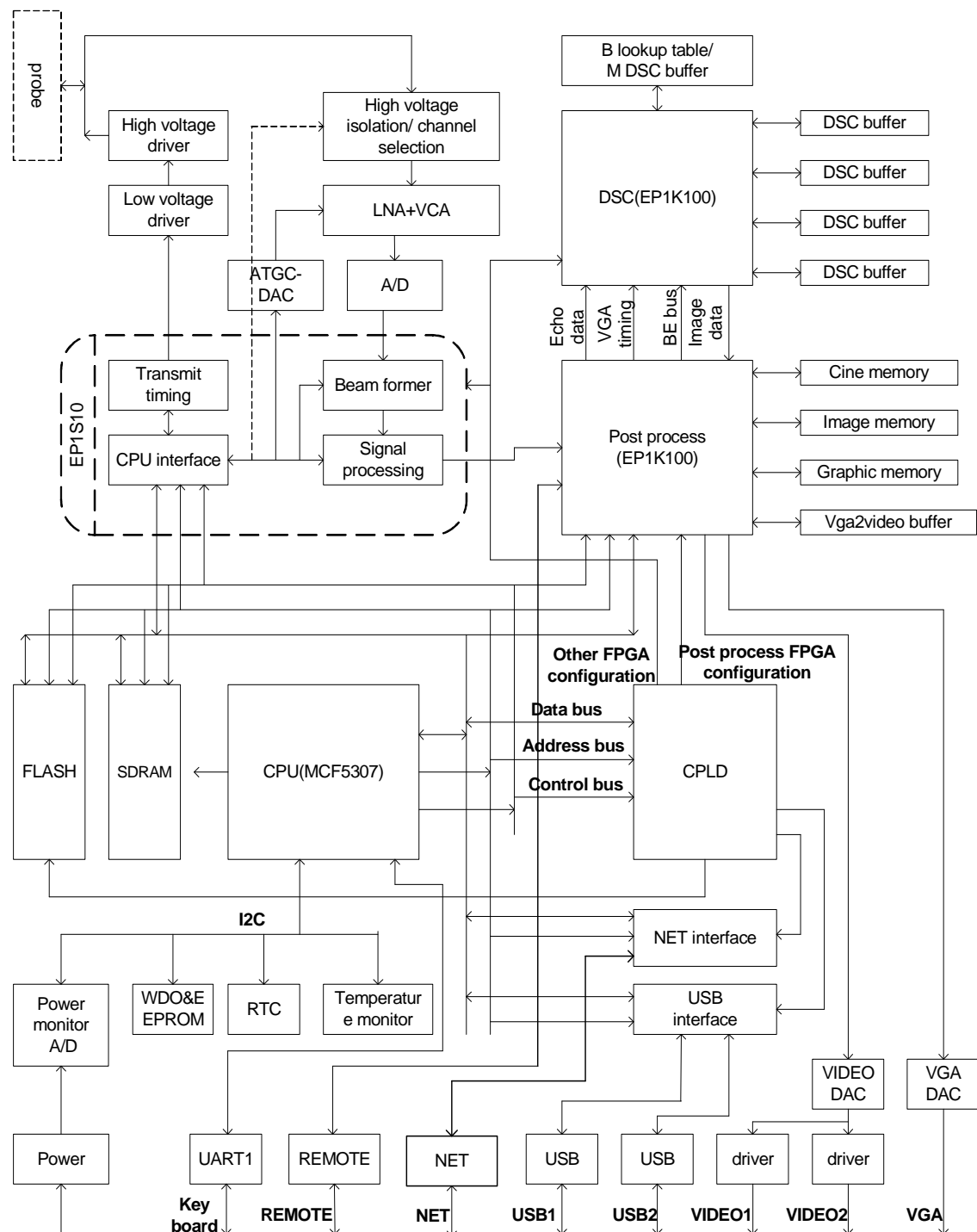


Figure 3-6 the schematic diagram of the main board

The CINE review and post-processing functions are realized within one FPGA, which is the ACEX1K100FC484 made by ALTERA. The chip has two SDRAM used for CINE review memory, and four SRAM respectively used for frame correlation buffer, graphics memory, image memory and video signal buffer, thus generating

the signals of frame correlation, graphics circuit, image storage VGA and VIDEO. In addition, this FPGA chip can also generate the horizontal and vertical synchronization signals for the VGA monitor and the control signal for the video printer.

The function of the DSC circuit is realized in one FPGA, which is the ACEX1K100QC208 made by ALTERA. The chip has one $256k \times 16$ SRAM used for the B-type DSC look-up table and the M-type memory, and four $128k \times 8$ SRAMs used for the B-type DSC memory.

The chip MCF5307, made by Motorola, is used as CPU and the control core of the DP-6600. The chip has SDRAM and FLASH as internal memory and Boot ROM, and it is externally connected with power detection A/D, watchdog, real-time clock and temperature detection circuit through IIC bus. The serial port for communicating with the keyboard is provided by the CPU.

The chip CPLD provides the interfaces between the CPU and the external circuits, including the USB control interface, network control interface and FPGA configuration interface, etc.

The DP-6600 has two video DACs, one for generating the monochromatic VGA signal, the other for generating the video signal. Since the system needs two video signal outputs, there are two operational amplifiers.

The chip for network interface provides the functions of MAC and PHY, and it is externally connected with a network transformer to isolate the network signal.

The chip for USB interfaces controls the two USB interfaces and is connected with an external power management chip. Each USB interface can provide maximum 500mA. If the current exceeds 500mA, the power for USB interfaces will be cut off automatically.

3.1.4.2. Definition of the main board socket

The socket P2 for connecting the main board and the transducer board is defined in the table below:

Table 3-8 Definition of the socket for connecting the main board and the transducer board

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
A	G	3	6	G	11	14	G	19	22	G	27	30	G	35	38	G	43	46	G	51	54	G	59	62	G	67	70	G	75	78	ID3	ID0
B	1	4	7	9	12	15	17	20	23	25	28	31	33	36	39	41	44	47	49	52	55	57	60	63	65	68	71	73	76	79	ENB	ID1
C	2	5	8	10	13	16	18	21	24	26	29	32	34	37	40	42	45	48	50	53	56	58	61	64	66	69	72	74	77	80	+5	ID2

A VME socket is adopted for connecting the main board and the transducer board, and it is the 650947-5 made by AMP.

In the table. G represents the analogue ground, and the +5V the A +5V power, and ID0 to ID3 represent the ID codes of the transducer board output. ENB is the transducer's selection signal from the main board, when ENB is low, the transducer A is selected and its ID code of the transducer A is the output; when ENB is high, the transducer B is selected and its ID code is the output.

The socket P4 for connecting the main board and the connection board is defined in the table below:

Table 3-5 Definition of the socket for connecting the main board and the connection board

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
A	PHV	NC	G	-5V	G	12V	G	A+5	A+5	A+5	G	HVC	G	G	2V5	G	1V5	1V5	G	G	3V3	3V3	G	G	13V5	VS	HS	G	TXD	G	D+5	D+5
B	PHV	NC	G	-5V	G	12V	G	A+5	A+5	A+5	G	G	G	G	2V5	G	1V5	1V5	G	G	3V3	3V3	G	G	13V5	G	G	G	G	G	D+5	D+5
C	PHV	NC	G	-5V	G	12V	G	A+5	A+5	A+5	G	G	G	G	2V5	G	1V5	1V5	G	G	3V3	3V3	G	G	13V5	G	B	G	RXD	G	D+5	D+5

A VME socket is adopted for connecting the main board and the connection board, and it is the 650947-5 made by AMP.

The main board is connected with the power board through the connection board, and the power signals transmitted from the power board include PHV, -5V, A+5V, 2.5V, 1.5V, 3.3V, 13.5V and D+5V. The main board outputs the HVC to control the HV output of the power board, and also outputs the serial signals RxDFromKB and TxDTToKB, and the VGA signals HS, VS and B.

3.1.4.3. Key signals and indicators

Table 3-6 key signals and indicators

	Attribute	Description
LD4	Indicator for CINE FPGA (U179)	On: the U179 configuration succeeds; the CINE review circuit, post-processing circuit and display circuit can work normally. Off: the U179 configuration fails, or the U179 isn't configured; the CINE review circuit, post-processing circuit and display circuit cannot work normally.
LD6	Indicator for DSC FPGA (U189)	On: the U189 configuration succeeds; B-type DSC circuit and M-type DSC circuit can work normally. Off: the U189 configuration fails, or U189 isn't configured; B-type DSC circuit and M-type DSC circuit cannot work normally.
LD7	Indicator for	On: the U197 configuration succeeds; the front end

	EP1S10 (U197)	transmission circuit, reception circuit, beam forming circuit and signal processing circuit can work normally. Off: the U197 configuration fails, or U197 isn't configured; the front end transmission circuit, reception circuit, beam forming circuit and signal processing circuit cannot work normally.
X2.3	External input clock for CPU	The frequency is 45MHz.
X3.3	Display clock for the system	The frequency is 25MHz.
U202.2	A+9V	Powers the low voltage pulse transmission circuit
U208.2	A+3.3V	For the high voltage isolation and reception selection circuit
U209.3	A-1.5V	For the high voltage isolation and reception selection circuit
U173.2	+3V	For the ADC circuit
VTGC	Test point for TGC control signal	The TGC control signal can be tested at this test point.
AHV-CNTL	PHV control signal	The PHV control signal can be tested at this test point.

3.1.5. The keyboard

The keyboard plays an important part in the information exchange between the system and the outside, and according to the functions it can be divided into several parts, such as the CPU circuit, DC/DC conversion circuit, keys control circuit, trackball control circuit, encoder control circuit, LED driver control circuit and STC A/D sampling circuit. The CPU circuit is comprised of one MCU chip and its peripheral circuits, and it is the core of the keyboard and used for coordinating and processing various information. The DC/DC conversion circuit is designed for providing different levels needed by the keyboard. The keys control circuit refers to the keys processing hardware, mainly comprised of a CPLD and its peripheral circuits. The trackball control circuit and encoder control circuit are used for converting the mechanical actions of the outside into the signals that can be identified by the MCU. The LED control circuit is used for indicating the states of the LEDs. The STC A/D sampling circuit is incorporated with slide potentiometer and amplifier and AD sample circuit, and it is mainly used for converting the analogue signal returned from the slide

potentiometer into the digital signal that can be accepted by the MCU.

The schematic diagram of the keyboard is shown as follows:

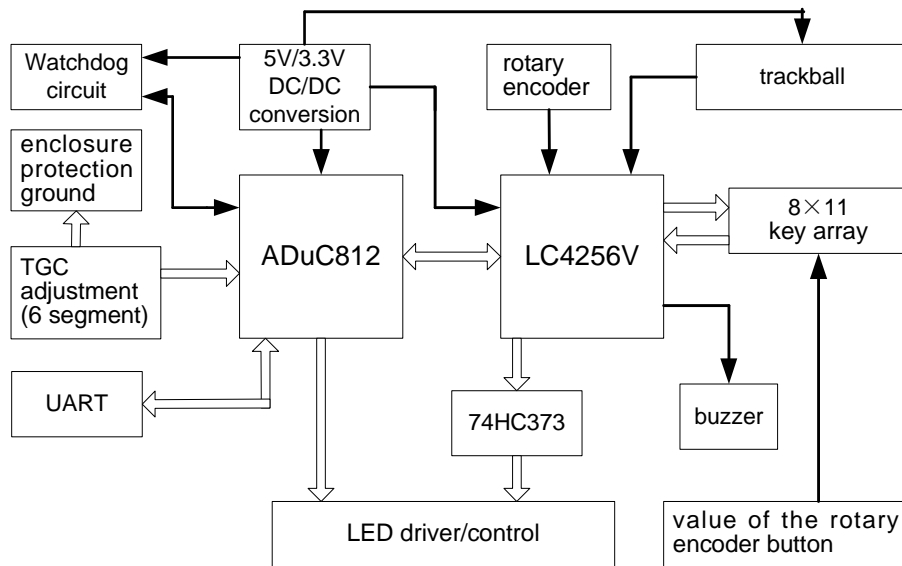


Figure 3-7 the schematic diagram of the keyboard

3.1.6. CRT display

The CRT is designed for converting the electric signal from the main board into high-speed electrons for striking the screen, and then the electrons are converted into the optical signal, therefore the image can be seen on the screen. The external indicator for CRT is used for judging whether the monitor works normally, and the indicator should be green when the monitor is receiving the synchronous signal, otherwise the indicator should be yellow.

3.1.7. Field tuning after replacing the board

After the main board is replaced, the system must be turned on to perform the overall self-test. Additionally all the interfaces must be tested, including the USB interface, network interface, video interface and video printer control interface, etc.

After the connection board is replaced, all the supply voltages should be tested on the connection board by means of a multimeter. Additionally it must be verified that the monitor and the keyboard can work normally, and it is recommended that the system be subjected to an overall self-test.

After the transducer board is replaced, the two different transducers should be respectively connected to the dual-transducer socket, to verify the normal switch between the two transducers and simultaneously observe the types of transducers

displayed on the screen to judge if the transducers are correctly switched. During the switch of the two transducers, you should hear the relays click. In addition, the user can place the connected transducer near an ear to listen if it chirps and simultaneously observes if the near field of the image is highlighted to judge whether the transducer is transmitting. It is recommended that the system be performed the overall self-test.

After the power board is replaced, all the supply voltages should be tested on the connection board by means of a multimeter. It must be verified that the monitor and the keyboard can work normally. And the system must be subjected to an overall self-test.

After the keyboard is replaced, the function tests must be performed for all keys, encoders, the trackball and the slide potentiometer to verify that all functions are normal. Additionally the back light of the keyboard must be observed to verify it is normal. And if a U disk is connected to the system to save files, observe whether the USB indicator on the keyboard flickers.

3.2 Principle of the Software

3.2.1. Features and functions of the real-time operating system

The system is a real-time multitask embedded system supported by a real-time operating system. It is comprised of two parts: the real-time multitask operating system and system application program, and it features:

1. Real-time
2. Responding to asynchronous events
3. Responding to synchronous events
4. Interrupt management
5. Definite conversion time and interrupt delay time
6. Advanced sequence arrangement

The operating system can realize the functions such as task conversion, task sequence arrangement, communications between tasks, synchronization, mutual repulsion and interrupt management, etc.

3.2.2. Description of the system software

3.2.2.1. The structure of the system software

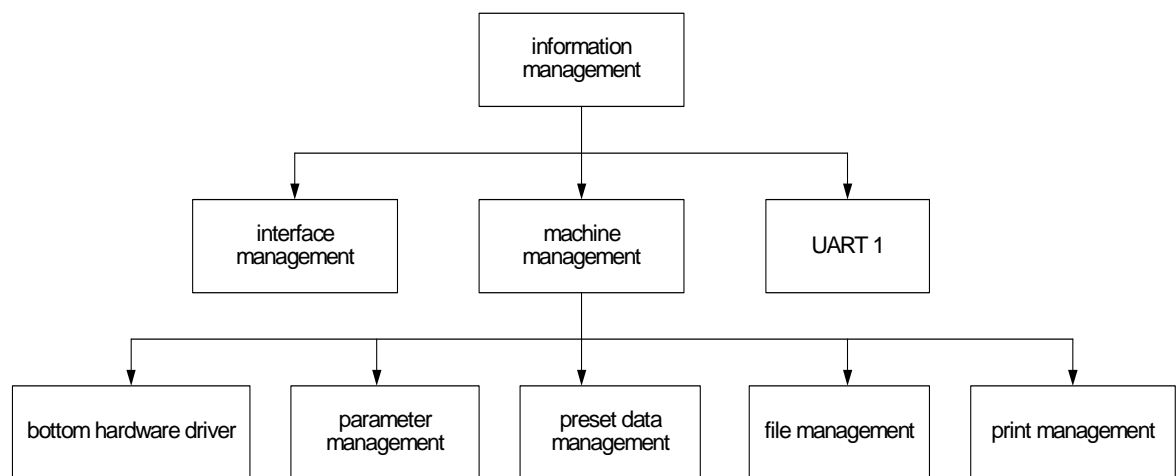


Figure 3-8 the structure of the system software

3.2.2.2. Description of object functions

1. Information management

The task of the information management object is to transfer and distribute information. The information is taken out from the system information box, and then distributed to other objects such as interface management and machine management.

2. Manager for booking and releasing information

This information-releasing manager doesn't generate a sample. However, it serves as an object in the system, managing the information booking or canceling the information booking, and releasing the information to the object that books the information.

3. Interface management object

The task of the interface management object is to manage all the graphics elements on the screen, such as menu, dialogue box, image window, static text, edit window, valid curve and cursor, etc.

4. Machine management objects

The machine management objects refer to a series of objects, which are aggregated based on the parameters and the other objects related to hardware drivers. These objects are designed to seal all the parameters and parameter operations that are related to machine characteristics.

5. Parameter management object

The parameter management object is designed for retaining the parameters, such as the preset data, the current true data and the parameter output. Additionally the parameter management object determines all the characteristics of the parameters.

6. Preset data management object

The preset data management object is designed for managing all the preset data stored in the flash memory. The preset data are aggregated based on the exam modes, and then stored in the corresponding sectors. The preset data management object has a data buffer, which saves the preset data based on the current exam mode.

7. Hardware driver

The hardware driver object is designed for driving the system hardware. It generally constructs its structure based on the functions.

8. File management object

The file management object is designed for providing all operations related to file reading or writing and the disks. It seals the functions related to the disks and files in the operating system.

9. Printing management object

The printing management object is designed for providing all the printing operations of the ink-jet printer. It is used for sealing the functions related to the graph/text printer. In the system, the printing management object prints the diagnostic reports based on the printing templates.

10. Serial port 1

The serial port 1 is used for managing the communications with operation panel.

11. System mailbox

HotMailBox

This mailbox is used for saving the information with first priority. Its data structure is FIFO rank.

TheMailBox

This mailbox is used for saving the information with common priority. Its data structure is FIFO rank.

TheMailBox2

This mailbox is used for saving the information with minimum priority. Its data structure is FIFO rank.

3.2.3. Software upgrading procedure

3.2.3.1. Entering the upgrading procedure

Entering the maintenance operation:

click 『File』 key

→click **“preset”**

→click **“maintenance”**

→the password dialogue window pops up:

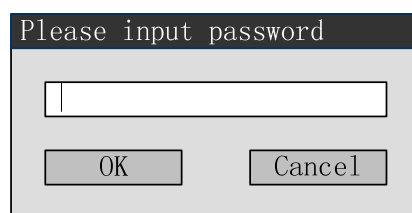


Figure 3-9 the password dialogue window

Enter the password “23002378” , and click **“OK”** to enter the maintenance menu:

	Maintenance
	Product
	Configure
	Sys Info
	Gray Test
Sys SW	Upgrade ▶
CINE FPGA	PIT Menu
Other FPGA	SelfDiagnosi
Start Logo	Return
Text Print Font	
Default Preset	
CIM	
Probe Data	

Figure 3-10 the maintenance menu

3.2.3.2. Upgrading operation

Each item in the upgrading submenu is used for the upgrading function. Perform the upgrading operation based on the different data that are described in the table below:

Table 3-7 the functions to be upgraded

Menu	Data	File name extension	AFTER UPGRADED
System software	Software	UPG	Prompt on turning

			off the system
CINE FPGA	Display circuit FPGA	FP1	Prompt on turning off the system
Other FPGAs	Other FPGAs in the system	FP2	Prompt on turning off the system
Start-up bitmap	The image displayed when the system starts up.	BMP	The system resets automatically
Text printing fond	The vector fond for printing the diagnostic reports	TTF	The system resets automatically
Factory default setup	the backup of factory DTA data in flash	DTA	The system resets automatically
Chinese entry	Chinese entry data	CIM	The system resets automatically
Transducer's data	The data of the transducers supported	PRB	The system resets automatically

Taking the system software as an example, the upgrading process is described as follows:

Put a U disk with UPG upgrading files into a USB interface.

→Click “system software” menu item, a file dialogue box pops up and opens:

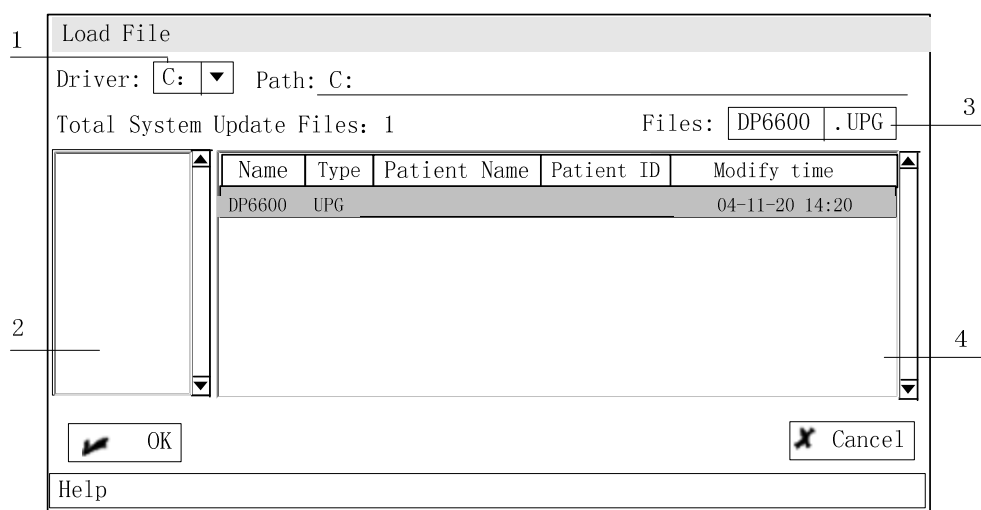


Figure 3-11 the dialogue box for loading files

→Select the file to be upgraded in the dialogue box. The meaning of each item is described as follows:

1. Drive path
2. Directory path
3. Name of the selected file
4. File list

→ Click OK button

The system software will be upgraded. After the upgrade finishes, the system will prompt:

Update finished, please re-
power!

Figure 3-12 the prompt information at the end of the upgrade

→ Turn off the machine, and then after a while, turn it on again.

Note: After the upgrade finishes, for some data it needs to turn off the machine and turn it on again; however, for other data, the system will reset automatically to enable the upgraded data.

Chapter4 System Start-up

4.1 System Start-up

The start-up process is described as follows:

1. The system finishes the initialization of CPU, DRAM and chip selection.
2. The system copies the firmware in the flash to DRAM.
3. The system runs the software in DRAM, configures CPU interrupt, and fills in the interrupt vector table.
4. The system configures the display circuit FPGA.
5. The start-up image displays.
6. The system configures other circuit FPGA.
7. The system reads out the preset data, and based on the preset, selects the exam mode and the transducer.
8. The front end is initialized based on the selected transducer.
9. The system initializes the scanning and back-end parameters, opens the scanning interrupt and performs the image scanning.
10. The system enters the start-up image.

Chapter5 Troubleshooting

5.1 Black Screen

If CRT appears black screen, adjust the knobs of contrast and brightness and tune the knobs in the middle. Additionally verify it is not the fault of connection wire of CRT.

Check the system according to the following chart:

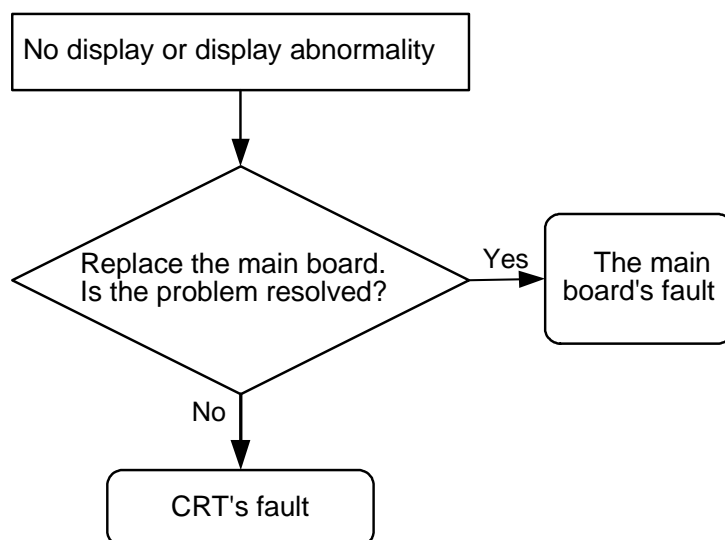


Figure 5-1 Solution of the black screen fault

5.2 No Response from the Keyboard

First verify it is not the fault of connection wire of the keyboard.

Check the system according to the following chart:

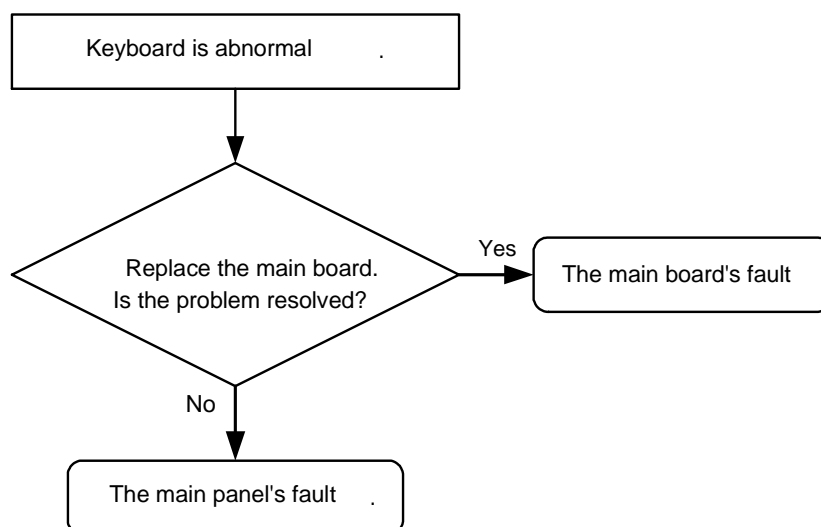


Figure 5-2 Solution of the keyboard fault

5.3 No Echo Signal in Image Area

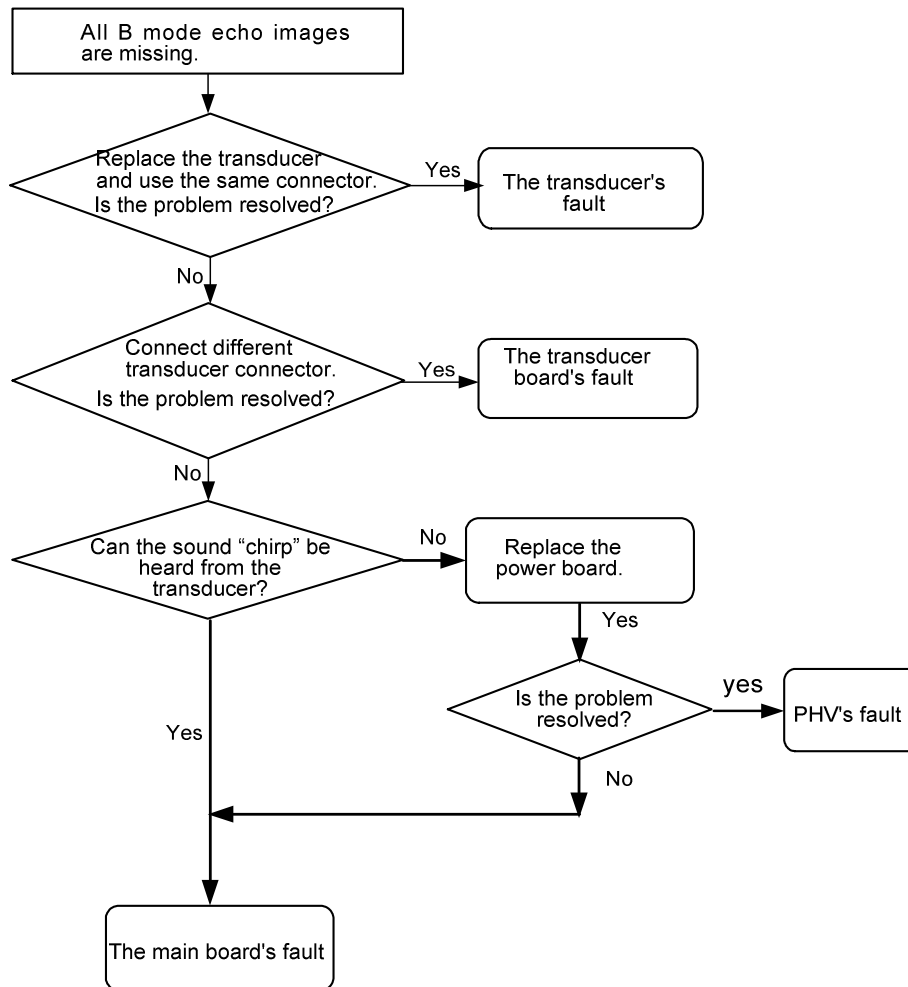


Figure 5-3 Solution of no echo signal in image area

5.4 Black Area in the Image (Black Strip)

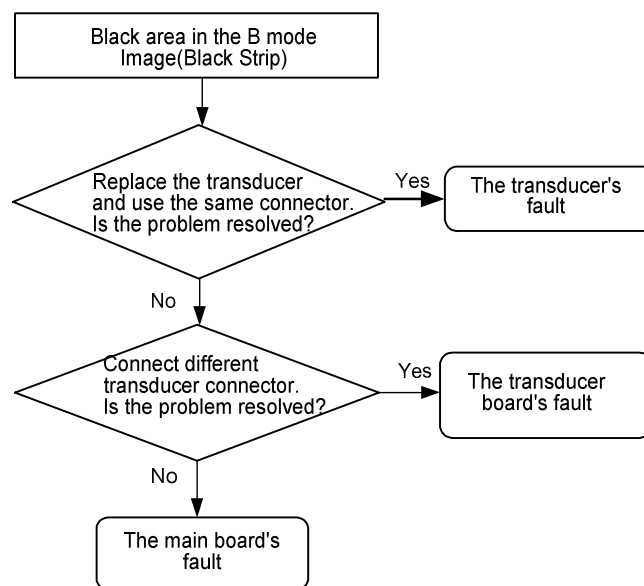


Figure 5-4 Solution of black area in the image

5.5 Image Interference

If it is abnormal in image area (e.g. interference, ripples and bright lines, etc.), first verify it is not interference from outside. Then check whether the system grounding is good, and whether there is other equipment nearby generating interference signals. In addition, verify that the transducer board shielding cover, the main board socket, the digital circuit shielding cover and the power board shielding cover are all in good condition.

Check the system according to the following chart:

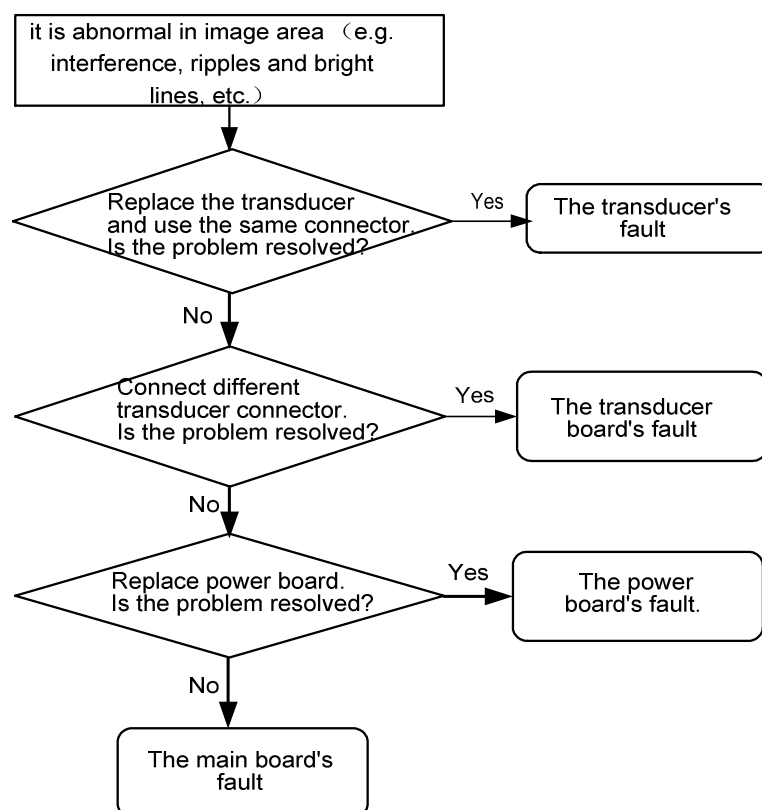


Figure 5-5 Solution of image interference

5.6 Back-end Circuits Fault

If it is the fault of CINE review circuit, DSC circuit, post-processing circuit, display circuit, FPGA configuration, network or USB, it can be resolved by replacing the main board. And the specific fault can be found by self-test.

5.7 Other Faults

Table 5-1 other faults list

No	FAULT	Cause	Remark
1	The fan doesn't work.	<ul style="list-style-type: none"> ◆ +12V power is abnormal ◆ The cable's fault ◆ The fan's fault 	Supply the +12V power directly by the power board and check the +12V voltage in the power board.
2	USB fault	<ul style="list-style-type: none"> ◆ The cable's fault ◆ The main board is abnormal ◆ The software doesn't support U disk or the printer. 	<ul style="list-style-type: none"> ◆ Replace USB interface cable ◆ Check the main board ◆ Use U disk or the printer

			of specified model
3	Video output fault	<ul style="list-style-type: none"> ◆ Video cable's fault (inside the main board) ◆ The main board is abnormal 	<ul style="list-style-type: none"> ◆ Check the corresponding video cable ◆ Check the main board
4	Network fault	<ul style="list-style-type: none"> ◆ The main board is abnormal 	<ul style="list-style-type: none"> ◆ First verify that the external network is connected correctly.

Chapter6 Maintenance and Cleaning

6.1 Maintenance to Be Performed By User

6.1.1. Cleaning the system

⚠Warning: Before cleaning the system, be sure to turn off the power and disconnect the power cable from the outlet. Cleaning the machine when the power is “On” may result in electric shock.

1. Cleaning the transducer

Perform the cleaning, disinfection and sterilization for the transducer according to the corresponding transducer's manual.

2. Cleaning the transducer socket

Use dry rag to wipe off the dirt on the transducer socket.

If it is hard to get rid of the dirt, use the mild detergent-soaked rag to wipe it off, then make the transducer socket air-dried.

3. Cleaning CRT

Use the glass cleaner-soaked rag to wipe CRT, and then make it air-dried.

NOTE: Do not use the detergent of hydrocarbon or the detergent for OA device to clean CRT. Otherwise it may cause degradation of performance for CRT.

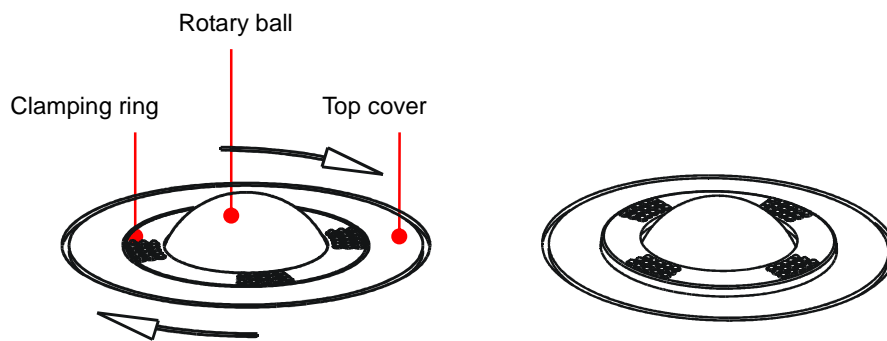
4. Cleaning the control panel, cover and bracket

Use dry rag to clean the surface of the machine. Or use the rag dipped in neutral detergent to wipe off the dirt, and then dry the machine by dry rag or make it air-dried.

5. Cleaning the trackball

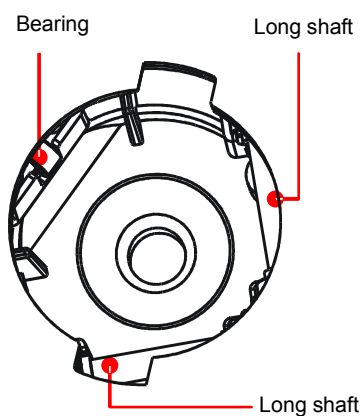
a) Disassembling the trackball

Press the bulges on the clamping ring by both hands and turn the ring about 45° clockwise until it lifts. Take out the ring and the rotary ball. Be careful not to drop the ball.



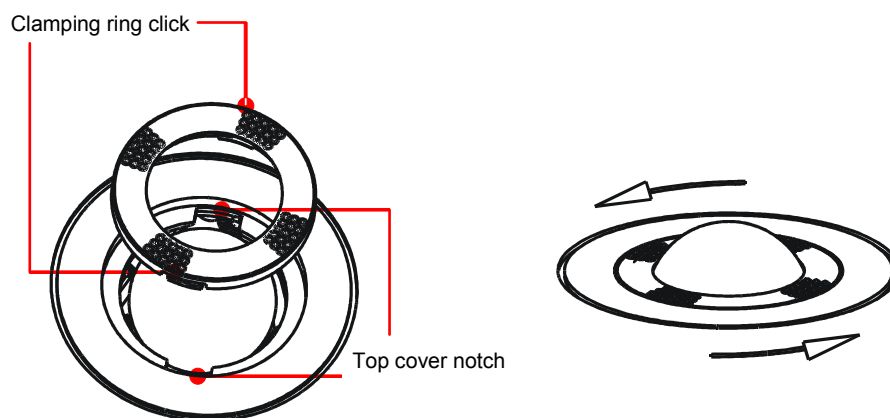
b) Cleaning the trackball


Clean the two long shafts, the bearing and the rotary ball with clean soft dry cloth or paper.



c) Installing the trackball

Put the rotary ball back in the trackball and then align the clamping ring click with the top cover notch. Press the bulges on the ring with both hands and turn the ring about 45° counterclockwise until the ring clicks. As the bulges are flush with the top cover, the ring is secured.



 Caution:	<p>1. Be careful not to allow water or liquid to enter the system during cleaning, otherwise it may result in malfunction or electric shock.</p> <p>2. To clean the connector, TGC controls and other connectors for the peripheral devices, contact the foreign sales distributor of Mindray. The cleaning done by the user may cause malfunction or degradation of performance.</p>
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6.1.2. Creating a backup copy of the system hard disk

To prevent any damage or loss of data stored in the system hard disk, users should create a backup copy of the hard disk periodically.

6.2 Maintenance to Be Performed By Service Personnel

The following checks are required to ensure the performance and safety of the system. Contact your MINDRAY representative when carrying out these checks, because they require special techniques.

Table 6-1 Cleaning and Maintenance Measures

Check category	Check item
Cleaning	Interior of the system Peripheral devices
Electric safety	Protective conductor resistance Earth leakage current Patient leakage current Patient auxiliary current Note: Refer to Appendix A electrical safety inspection for detail.
Mechanical safety	The casters The caster mounting sections The monitor mounting mechanism Operating panel Mounting mechanism for the peripheral devices Other mechanical parts External appearance of the transducer
Image recording	Images in each mode Image recording using the standard transducer

Appendix A ELECTRICAL SAFETY INSPECTION

The following electrical safety tests are recommended as part of a comprehensive preventive maintenance program. They are a proven means of detecting abnormalities that, if undetected, could prove dangerous to either the patient or the operator. Additional tests may be required according to local regulations.

All tests can be performed using commercially available safety analyzer test equipment. These procedures assume the use of a 601PRO_{XL} International Safety Analyzer or equivalent safety analyzer. Other popular testers complying with IEC 60601-1 used in Europe such as Fluke, Metron, or Gerb may require modifications to the procedure. Follow the instructions of the analyzer manufacturer.

The consistent use of a safety analyzer as a routine step in closing a repair or upgrade is emphasized as a mandatory step if an approved agency status is to be maintained. The safety analyzer also proves to be an excellent troubleshooting tool to detect abnormalities of line voltage and grounding, as well as total current loads.

ELECTRICAL SAFETY INSPECTION**1- Power Cord Plug****TEST PROCEDURE****◆ The Power Plug**

The Power Plug Pins	No broken or bent pin. No discolored pins.
The Plug Body	No physical damage to the plug body.
The Strain Relief	No physical damage to the strain relief. No plug warmth for device in use.
The Power Plug	No loose connections.

◆ The Power Cord

The Power Cord	<p>No physical damage to the cord. No deterioration to the cord.</p> <p>--For devices with detachable power cords, inspect the connection at the device.</p> <p>--For devices with non-detachable power cords, inspect the strain relief at the device.</p>
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ELECTRICAL SAFETY INSPECTION

2- Device Enclosure And Accessories

TEST PROCEDURE

◆ Visual Inspection

The Enclosure and Accessories	No physical damage to the enclosure and accessories.
	No physical damage to meters, switches, connectors, etc.
	No residue of fluid spillage (e.g., water, coffee, chemicals, etc.).
	No loose or missing parts (e.g., knobs, dials, terminals, etc.).

◆ Contextual Inspection

The Enclosure and Accessories	No unusual noises (e.g., a rattle inside the case).
	No unusual smells (e.g., burning or smoky smells, particularly from ventilation holes).
	No taped notes that may suggest device deficiencies or operator concerns.

ELECTRICAL SAFETY INSPECTION

3- Device Labeling

TEST PROCEDURE

Check the labels provided by the manufacturer or the healthcare facilities are present and legible.

- *Main Unit Label*
- *Integrated Warning Labels*
- *Slope and High Voltage Caution Label*
- *Don't Stress Label*

ELECTRICAL SAFETY INSPECTION

4- Protective Earth Resistance

VOERVIEW

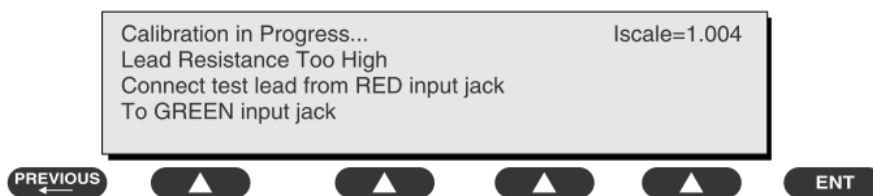
Protective Earth Resistance is measured using the RED test lead attached to the DUT Protective Earth terminal or enclosure. Select the test current by pressing SOFT KEY 3 to toggle between 1AMP, 10AMP, and 25AMP. The front panel outlet power is turned off for this test.

The following conditions apply: L1 and L2 Open.

TEST PROCEDURE

◆ Prepare

- 1) First select the test current that will be used for performing the Protective Earth Resistance test by pressing AMPERES (SOFT KEY 3).
- 2) Connect the test lead(s) between the RED input jack and the GREEN input jack.
- 3) Press CAL LEADS. The 601PRO will measure the lead resistance, and if less than 0.150 Ohms, it will store the reading and subtract it from all earth resistance readings taken at the calibrated current.



- 4) If the calibration fails, the previously stored readings will be used until a passing calibration has occurred.

◆ Warning

During Earth Resistance testing, the DUT must be plugged into the 601PRO front outlet. If the DUT fails Earth Resistance, discontinue tests and label the device defective.

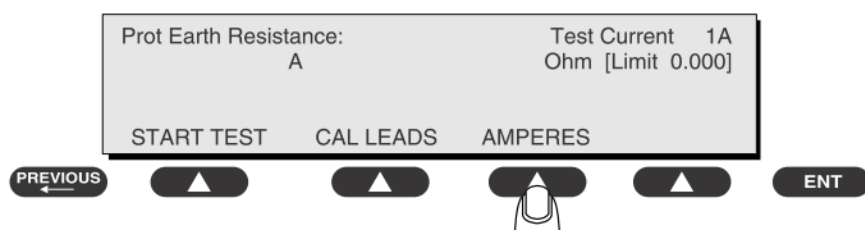
◆ Perform the Test

- 1) From the MAIN MENU, or with the outlet unpowered, plug the DUT into the 601PRO front panel outlet.

ELECTRICAL SAFETY INSPECTION

4- Protective Earth Resistance

- 2) Attach the 601PRO RED input lead to the device's Protective Earth terminal or an exposed metal area.
- 3) Press shortcut key 3. The Protective Earth Resistance test is displayed.
- 4) Press SOFT KEY 3 to select a test current (1AMP, 10AMP, or 25AMP). The selected test current is displayed in the upper right corner of the display.



- 5) Press START TEST to start the test. The test current is applied while resistance and current readings are taken. This takes approximately 5 seconds.
- 6) Press the print data key at any time to generate a printout of the latest measurement(s).

◆ Note

When "Over" is displayed for Ohms, this signifies that a valid measurement was not obtained because either an open connection was detected or that the measurement was not within range. Readings greater than 9.999 Ohms will be displayed as Over.

◆ Failure

Once it reaches the limitation, stop using and inform the Customer Service Engineer for analysis and disposal.

LIMITS

ALL COUNTRIES R = 0.2Ω Maximum

ELECTRICAL SAFETY INSPECTION

5- Earth Leakage Test

OVERVIEW

Run an Earth Leakage test on the device being tested before performing any other leakage tests.

Leakage current is measured the following ways:

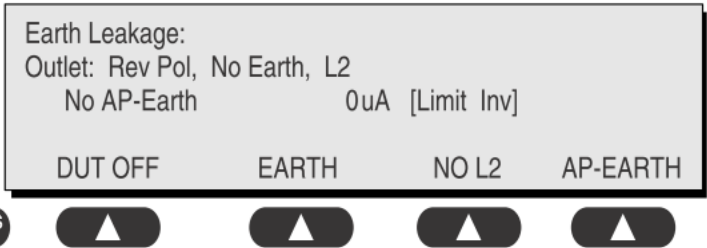
- ◆ Earth Leakage Current, leakage current measured through DUT outlet Earth
- ◆ Earth Leakage Current AP-EARTH (ALL Applied Parts connected to Earth), leakage current measured through DUT outlet Earth

There is no need to attach a test lead; the 601PRO automatically connects the measuring device internally.

TEST PROCEDURE

◆ Perform the Test

- 1) From the MAIN MENU, or with the outlet unpowered, plug the DUT into the 601PRO front panel outlet, and turn on the device.
- 2) Attach the device's applied parts to the 601PRO applied part terminals if applicable.
- 3) Press shortcut key 4. The Earth Leakage test appears on the display, and the test begins immediately:



- SOFT KEY 1 toggles the DUT outlet Polarity from Normal to Off to Reverse.
 - SOFT KEY 2 toggles the DUT outlet from Earth to No Earth.
 - SOFT KEY 3 toggles the DUT outlet from L2 to No L2.
 - SOFT KEY 4 toggles the AP to Earth to No AP to Earth.
- 4) Press the print data key at any time to generate a printout of the latest measurement.

◆ Failure

ELECTRICAL SAFETY INSPECTION

5- Earth Leakage Test

Check any broken of the AC/DC adapter and its cable. Replace a new one if any portion defective.

Check any broken of the enclosure. Replace any defective part.

Inspect wiring for bad crimps, poor connections, or damage.

Test the wall outlet; verify it is grounded and is free of other wiring abnormalities. Notify the user or owner to correct any deviations. As a work around, check the other outlets to see if they could be used instead.

Change another probe to confirm if the fail is caused by console.

Inspect wiring for bad crimps, poor connections, or damage.

If the leakage current measurement tests fail on a new unit and if situation can not be corrected, submit a Safety Failure Report to document the system problem. Remove unit from operation.

If all else fails, stop using and inform the Customer Service Engineer for analysis and disposal.

LIMITS

For UL60601-1: 300 μ A Normal Condition

1000 μ A Single Fault Condition

For IEC60601-1: 500 μ A Normal Condition

1000 μ A Single Fault Condition

ELECTRICAL SAFETY INSPECTION

6- Patient Leakage Current

OVERVIEW

Patient leakage currents are measured between a selected applied part and mains earth. All measurements may have either a true RMS or a DC-only response.

TEST PROCEDURE

◆ Prepare

Perform a calibration from the Mains on Applied Part menu.

The following outlet conditions apply when performing this test:

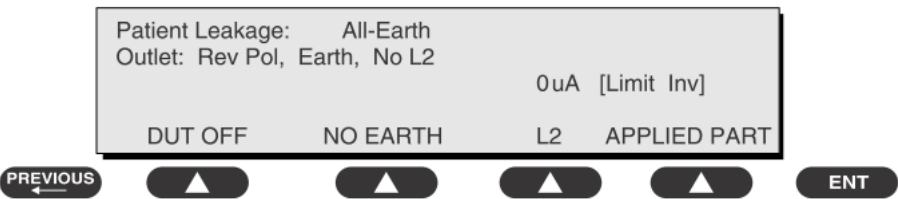
Normal Polarity, Earth Open, Outlet ON	Normal Polarity, Outlet ON
Normal Polarity, L2 Open, Outlet ON	Reversed Polarity, Outlet ON
Reversed Polarity, Earth Open, Outlet ON	Reversed Polarity, L2 Open, Outlet ON

◆ Warning

If all of the applied parts correspond to the instrument type, the applied parts will be tied together and one reading will be taken. If any of the applied parts differ from the instrument type, all applied parts will be tested individually, based on the type of applied part. This applies to Auto and Step modes only.

◆ Perform the Test

- 1) From the MAIN MENU, or with the outlet unpowered, plug the DUT into the 601PRO front panel outlet, and turn on the device.
- 2) Attach the applied parts to the 601PRO's applied part terminals.
- 3) Press shortcut key 6. The Patient Leakage test is displayed, and the test begins immediately.



ELECTRICAL SAFETY INSPECTION

6- Patient Leakage Current

- 4) Press APPLIED PART (SOFT KEY 4) at any time to select the desired applied part leakage current.
- 5) Modify the configuration of the front panel outlet by pressing the appropriate SOFT KEY on the 601PRO.
- 6) Press the print data key at any time to generate a printout of the latest measurement.

◆ Note

If the current test standard being used does not include Patient Leakage DC readings, or the DC option is not enabled, then DC readings will not be available through the APPLIED PART SOFT KEY selections. Refer to Chapter 8, Standards and Principles.

◆ Failure

Check any broken of the AC/DC adapter and its cable. Replace a new one if any portion defective.

Check any broken of the enclosure. Replace any defective part.

Inspect wiring for bad crimps, poor connections, or damage.

Test the wall outlet; verify it is grounded and is free of other wiring abnormalities. Notify the user or owner to correct any deviations. As a work around, check the other outlets to see if they could be used instead.

Change another probe to confirm if the fail is caused by console.

Inspect wiring for bad crimps, poor connections, or damage.

If the leakage current measurement tests fail on a new unit and if situation can not be corrected, submit a Safety Failure Report to document the system problem. Remove unit from operation.

If all else fails, stop using and inform the Customer Service Engineer for analysis and disposal.

LIMITS

For BF :transducer

100 μ A Normal Condition

500 μ A Single Fault Condition

ELECTRICAL SAFETY INSPECTION

7- Mains on Applied Part Leakage

OVERVIEW

The Mains on Applied Part test applies a test voltage, which is 110% of the mains voltage, through a limiting resistance, to selected applied part terminals. Current measurements are then taken between the selected applied part and earth. Measurements are taken with the test voltage (110% of mains) to applied parts in the normal and reverse polarity conditions as indicated on the display.

The following outlet conditions apply when performing the Mains on Applied Part test.

Normal Polarity;

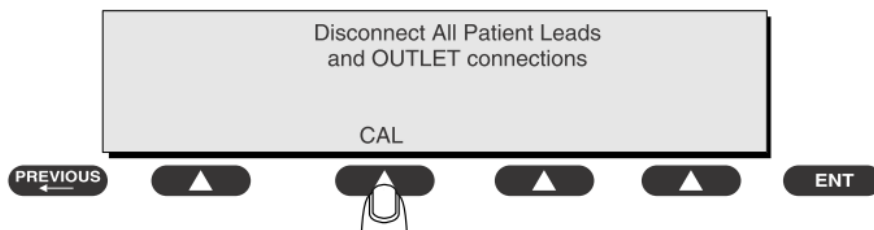
Reversed Polarity

TEST PROCEDURE

◆ Prepare

To perform a calibration from the Mains on Applied Part test, press CAL (SOFT KEY 2).

- 1) Disconnect ALL patient leads, test leads, and DUT outlet connections.
- 2) Press CAL to begin calibration, as shown:



If the calibration fails, the previously stored readings will be used until a passing calibration has occurred. Also, the esc/stop key has no effect during calibration.

- 3) When the calibration is finished, the Mains on Applied Part test will reappear.

◆ Warning

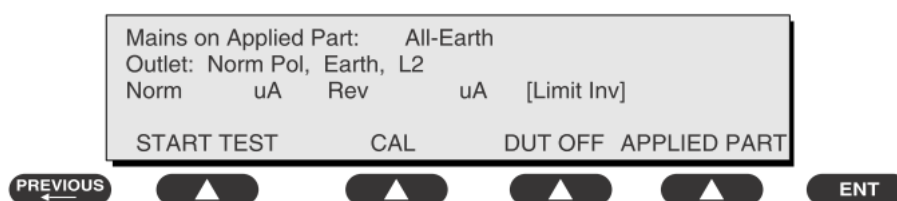
- 1) A 2-beep-per-second signal indicates high voltage present at the applied part terminals while a calibration is being performed.
- 2) High voltage is present at applied part terminals while measurements are being taken.

ELECTRICAL SAFETY INSPECTION

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◆ Performance

- 1) From the MAIN MENU, or with the outlet unpowered, plug the DUT into the 601
- 2) Attach the applied parts to the 601PRO applied part terminals.
- 3) Attach the red terminal lead to a conductive part on the DUT enclosure.
- 4) Press shortcut key 7. The Mains on Applied Part test is displayed.



- 5) Select the desired outlet configuration and applied part to test using the appropriate SOFT KEYS:
- 6) Press START TEST (SOFT KEY 1) to begin the test.
- 7) Press the print data key to generate a printout of the latest measurement.

◆ Note

If all of the applied parts correspond to the instrument type, the applied parts will be tied together and one reading will be taken. If any of the applied parts differ from the instrument type, all applied parts will be tested individually, based on the type of applied part. This applies to Auto and Step modes only.

◆ Failure

Check any broken of the AC/DC adapter and its cable. Replace a new one if any portion defective.

Check any broken of the enclosure. Replace any defective part.

Inspect wiring for bad crimps, poor connections, or damage.

Test the wall outlet; verify it is grounded and is free of other wiring abnormalities. Notify the user or owner to correct any deviations. As a work around, check the other outlets to see if they could be used instead.

Change another probe to confirm if the fail is caused by console.

Inspect wiring for bad crimps, poor connections, or damage.

If the leakage current measurement tests fail on a new unit and if situation can not be

ELECTRICAL SAFETY INSPECTION

7- Mains on Applied Part Leakage

corrected, submit a Safety Failure Report to document the system problem. Remove unit from operation.

If all else fails, stop using and inform the Customer Service Engineer for analysis and disposal.

LIMITS

For BF: transducer

5000 μ A

ELECTRICAL SAFETY INSPECTION FORM**(Class I equipment)****Overall assessment:**

Scheduled inspection	Test item: 1, 2, 3, 4, 5, 6, 7
Unopened repair type	Test item: 1, 2, 3
Opened repair type, not modify the power part including transformer or patient circuit board	Test item: 1, 2, 3, 4
Opened repair type, modify the power part including transformer	Test item: 1, 2, 3, 4, 5
Opened repair type, modify patient circuit board	Test item: 1, 2, 3, 4, 6, 7

Location:				Technician:	
Equipment:				Control Number:	
Manufacturer:		Model:		SN:	
Measurement equipment /SN:				Date of Calibration:	
INSPECTION AND TESTING				Pass/Fail	Limit
1	Power Cord Plug				
2	Device Enclosure and Accessories				
3	Device Labeling				
4	Protective Earth Resistance		Ω		Max 0.2 Ω
5	Earth Leakage	Normal condition(NC)	____ μ A		Max: NC: 300 μ A(refer to UL60601-1) * NC: 500 μ A(refer to IEC60601-1) * SFC: 1000 μ A
		Single Fault condition(SFC)	____ μ A		
6	Patient Leakage Current	Normal condition(NC)	<input type="checkbox"/> BF____ μ A		Max: BF applied part: NC:100 μ A, SFC: 500 μ A
		Single Fault condition(SFC)	<input type="checkbox"/> BF____ μ A		
7	Mains on Applied Part Leakage		<input type="checkbox"/> BF____ μ A		Max: BF applied part: 5000 μ A

Note:

The equipment which sell to America shall comply with the requirement of UL60601-1, others shall comply with the requirement of IEC60601-1

Name/ Signature: _____ Date: _____
