HS-50F, HS-50V, HS-50H, HS-50S, HS-30S, GS-50S, GS-30S

Insufflator

Service Manual

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2. All parts for replacement and accessories and consumables used during maintenance are provided or certified by Mindray.
3. Relevant electrical equipment meets the requirements of national standards and this Service Manual.
4. Product operations are carried out in accordance with this Service Manual.

Version Information

The version of this Service Manual is subject to update without notice due to changes in software or technical specifications. The version information of this Service Manual is as follows:

- Version No.: 2.0
- Issue date: May 2021

Preface

Description

This Service Manual presents detailed information on the hardware composition, installation, disassembly, test and troubleshooting of the product and relevant accessories to help service personnel effectively address common problems. Comprehensive briefings on product structure and design principle are not included. For issues that could not be addressed, contact our Customer Service Department.

The product introduction described in this Service Manual is based on a fully configured product. Therefore, certain content may not be applicable to your product. If you have any question, please contact us.

Please carefully read this Service Manual and fully understand the content before performing product maintenance. Otherwise, incorrect operation may cause personal injury or damage to product.

Intended Audience

This Service Manual is geared for professional biomedical engineers, authorized service personnel and after-sales representatives responsible for product maintenance.

Content

1 Safety

1.1 Safety Information

This chapter lists the basic safety information that should be paid attention to and observed by users when they use the insufflator. The identical or similar safety information and/or the safety information related to specific operations will be described in each chapter.

⚠DANGER

- **Indicates an imminent hazard that, if not avoided, will result in death or serious injury.**

⚠WARNING

- **Indicates a potential hazard or unsafe practice that, if not avoided, could result in death or serious injury or property damage.**

⚠CAUTION

- **Indicates a potential hazard or unsafe practice that, if not avoided, could result in minor personal injury or product/property damage.**

NOTE

- **Provides application tips or other useful information to ensure that you get the most from your product.**

1.1.1 DANGER

⚠DANGER

- **Do not use this system in an environment with flammable gas or flammable liquid. Otherwise, it may cause an explosion.**
- **This insufflator must use medical-grade CO_2 gas. Do not use other gases. Using gases other than CO_2 may cause fire, poisoning or complications. Using non-medical-grade and contaminated CO_2 may cause malfunctions during inflation pressure adjustment and cause serious injury to the patient. Use high-pressure pipes, pressure relief valves or wall fittings to connect CO_2 gas cylinders or medical gas pipelines as described in this Service Manual.**
- **Do not use this product for intrauterine inflation. This product cannot be used for uterine cervix dilation.**
- **Do not connect the product to the abdominal cavity (to the air) when it is powered on. Instead, connect it to the abdominal cavity after it passes the self-inspection.**
- **During actual use, position the patient end of the insufflator so that the associated pipeline is as high as possible above the inflation site and the liquid on the patient end flows back to the insufflator rather than flowing into the pipeline due to gravity.**
- **A spare CO_2 gas cylinder should be available when an insufflator is being used, so that the exhausted CO_2 gas cylinder can be quickly replaced during use.**
- **A spare insufflator should be available to prevent the operation from being interrupted due to an equipment failure.**

1.1.2 WARNING

⚠WARNING

- **The power plug of this system must be connected to a grounded power socket (3-pin). The socket must meet the requirements on the rated power identification plate of the insufflator. Using an adapter or multi-function socket may affect the grounding effect and cause the leakage current to exceed the safety requirements.**
- **Mindray recommends connecting the insufflator to a socket on wall instead of using an extension cord. Use only sockets certified by Mindray.**
- **Use only accessories and peripherals certified by Mindray.**
- **During the operation of the system, the ground terminal of the system must be connected reliably to the earth, and the ground cable must be connected when the system is off. Otherwise, it will cause an electric shock.**
- **Follow the correct electrical connection method to connect the power supply and the earth. Otherwise, an electric shock may occur. Do not connect the ground cable to any gas pipeline**

or water pipe. Otherwise, it will cause poor grounding or risk of explosion.

- **Unplug the power cable before cleaning the insufflator. Otherwise, it may cause an electric shock and equipment damage.**
- **Do not spill any liquid on the insufflator or let it flow into the insufflator. Otherwise, it may cause an electric shock or equipment damage. If you accidentally spill liquid on the insufflator, turn off the power immediately and contact our service representative.**
- **Transportation precautions: When you need to move the system, hold both sides of the system tightly. Otherwise, the system may be damaged due to abnormal stress. Do not move the insufflator in the left and right directions. Otherwise, the system may tip over.**
- **All analog and digital devices connected to this system must be certified in accordance with designated IEC standards (for example, IEC 60950 information technology equipment standards and IEC 60601-1 medical equipment standards). In addition, all configurations comply with the requirements of the valid version of the GB9706.15 system standard. The personnel responsible for connecting additional equipment to the input/output signal ports should configure the medical system and ensure that the system complies with the GB9706.15 standard.**
- **Do not use the insufflator in places with high oxygen concentration, oxides such as nitrous oxide (N_2O), flammable gases, and flammable liquids in the nearby. Otherwise, it may cause an explosion or fire since the insufflator lacks explosion-proof functions.**
- **Keep the cylinder upright. Fix it on a wall or other stable structure to prevent it from tilting. If the cylinder is placed horizontally or tilted, the liquefied CO_2 will flow into the inflation pipeline in the insufflator, resulting in the inflation failure.**
- **Using this insufflator simultaneously with electronic devices such as high-frequency electric knife, high-frequency treatment equipment or defibrillator may cause an electric shock to the patient. Do not use this insufflator under strong electromagnetic conditions.**

1.1.3 CAUTION

⚠CAUTION

- **Electromagnetic field will affect performance of the equipment. Therefore, other devices used around this equipment must conform to the corresponding EMC requirements. Mobile phones, X-ray devices or MRI devices are possible sources of interference as they may emit higher levels of electromagnetic radiation.**
- **Before connecting the equipment to a power supply, check that the voltage and frequency ratings of the power supply are the same as those indicated on the equipment's label or in this manual.**
- **Protect the equipment from damage caused by drop, impact, strong vibration or other mechanical force.**

1.1.4 NOTE

NOTE

- **Refer to the Operator's Manual for detailed operation and other information.**
- **This manual describes this product with the complete configuration and functions. The product you purchase may not have some configuration or functions.**

1.2 Equipment Symbols

Symbol	Detailed Description
	Date of manufacture
	SN
	Equipotential
	CE mark
	Follow the instructions of the user manual.
	This product contains certain hazardous substances and can be used safely during its environmental friendly use period (EFUP), and should enter into the recycling system after the EFUP. The EFUP for this product is 20 years.
	NOTE! Refer to instruction manual/booklet
	Temperature limitation
	Humidity limitation
	Alternating current
	Atmospheric pressure limitation
	TYPE CF APPLIED PART
	CO_2 smoke exhaust valve

Symbol	Detailed Description
	CO_2 inlet
	CO_2 outlet
	Heating port
	Fuse
	Earth terminal
	Foot switch

Table 1-1 Equipment Symbols

NOTE

- **YOUR EQUIPMENT MAY NOT HAVE ALL ABOVE SYMBOLS.**

FOR YOUR NOTES

2 Product Overview

2.1 Overview

2.1.1 Functions

The product is used in laparoscopic surgeries to inject CO_2 into the abdominal cavity and remove smoke from the abdominal cavity, so as to ensure the necessary space and visual field during the operation and observation.

Main functions are as follows:

1. Gas injection
   - ◆ After the gas injection function of the insufflator is turned on, the insufflator can inject the CO_2 gas from a qualified gas source smoothly
2. Gas pressure and flow monitoring
   - ◆ During the gas injection process, the insufflator continues monitoring the gas pressure and flow,
3. Gas heating (optional)
   - ◆ Insufflator can uses the heating insufflator tube (optional) to heat the gas.
4. Smoke exhaust (optional)
   - ◆ The smoke exhaust function can quickly eliminate the abdominal smoke while still maintaining the suitable air pressure automatically.

2.1.2 Model Comparison

Model	Flow setting range (L/min)	Heating	Smoke exhaust	Foot switch	Heating insufflator tube
HS-50F	0.1-50	Yes	Yes	Yes	Yes
HS-50V	0.1-50	No	Yes	Yes	No
HS-50H	0.1-50	Yes	No	No	Yes
HS-50S	0.1-50	No	No	No	No
HS-30S	0.1-30	No	No	No	No
GS-50S	0.1-50	No	No	No	No
GS-30S	0.1-30	No	No	No	No

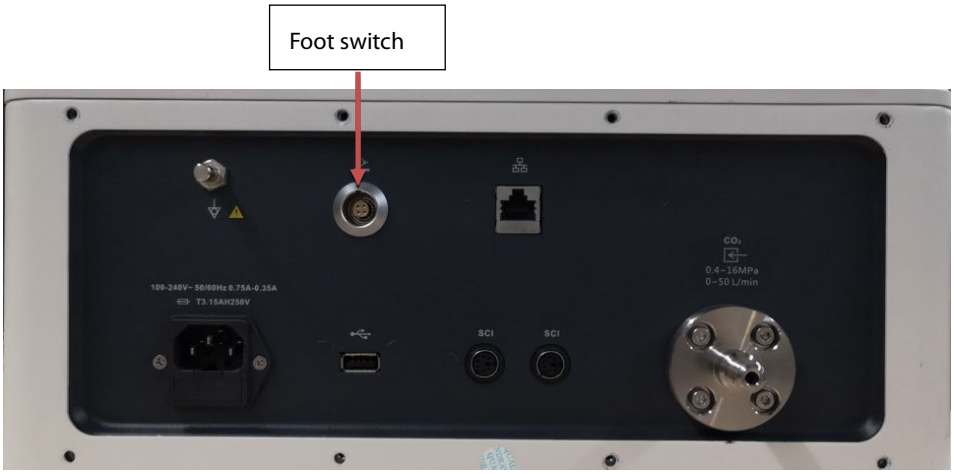
2.1.3 Versions

The version of the insufflator can be identified by the software version or the position of the foot switch on the back of the insufflator.

◆ Insufflator V1.0:

The software version is lower than 01.06.0.01 (included) (see section 5.7.3.6 for the software version).

The foot switch connector is on the left:



Note: All insufflators sold in Russia are V2.0 despite that their foot switches are on the left.

◆ InsufflatorV2.0:

The software version is higher than 01.07.0.20 (included) (see section 5.8.5 for the software version).

The foot switch connector is on the right:

Note: All insufflators sold in Russia are V2.0 despite that their foot switches are on the left.

2.1.4 Environment Information

The insufflator is intended for use in the operation room for minimally invasive abdominal operation where the average working conditions are as follows:

1. Operating ambient temperature: 0°C-40°C.
2. Operating relative humidity: 30%-85%.
3. Atmospheric pressure: 700hPa-1060hPa.

4. Power supply: overall input voltage: AC 100-240V±10%; frequency: 50/60Hz±1Hz.
5. Overall input current: 0.75-0.35A.
6. Fuse: T3.15AH250V
7. Transportation\storage temperature: -20°C to 55°C
8. Transportation\storage humidity: 10%-95%
9. Gas medium: CO_2
10. Gas pressure: 0.4-16MPa
11. Noise: ≤50 dBA

2.2 Appearance

2.2.1 Front Panel

Figure 2-1 Front Panel of Insufflator

Description of front panel:

1. Power button: Turns on the insufflator.
2. CO_2 inflation connector: CO_2 can be injected when the gas injection function is turned on.
3. Smoke exhaust valve (optional): Controls the exhaust flow.
4. Heating connector: Connects to the heating insufflator tube.
5. Control panel of insufflator: A 7.0-inch touch screen that displays and controls the status of the insufflator

2.2.2 Rear Panel

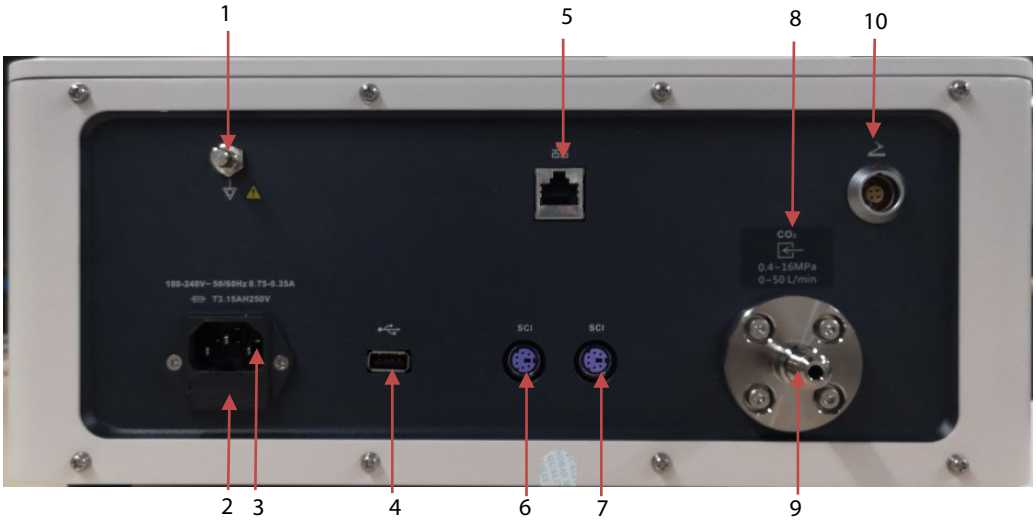


Figure 2-2 Rear Panel of Insufflator

Description of rear panel:

1. Equipotential grounding terminal: when using the equipment together with other devices, connect their equipotential grounding terminals together to eliminate the potential difference between them
2. Fuse box
3. AC power input socket: It is used to connect to an AC power supply. AC power input socket: It is used to connect to an AC power supply.
4. USB connector: It is used to export logs and upgrade software.
5. Network connector: It is used to connect to PC and upgrade software.
6. SCI connector: It is used to connect to other Mindray equipment.
7. SCI connector: It is used to connect to other Mindray equipment.
8. CO_2 gas input label: It is the gas source input label.
9. CO_2 inlet: It is used to connect to the CO_2 gas source that meets the requirements of this insufflator.
10. Foot switch connector: It is used to connect to the foot switch.

2.3 Product Principle

2.3.1 System Principle

Based on functions, the system block diagram of the insufflator is shown in Figure 3. The system is mainly composed of pressure relief valves, insufflator module, smoke exhaust module, and control unit.

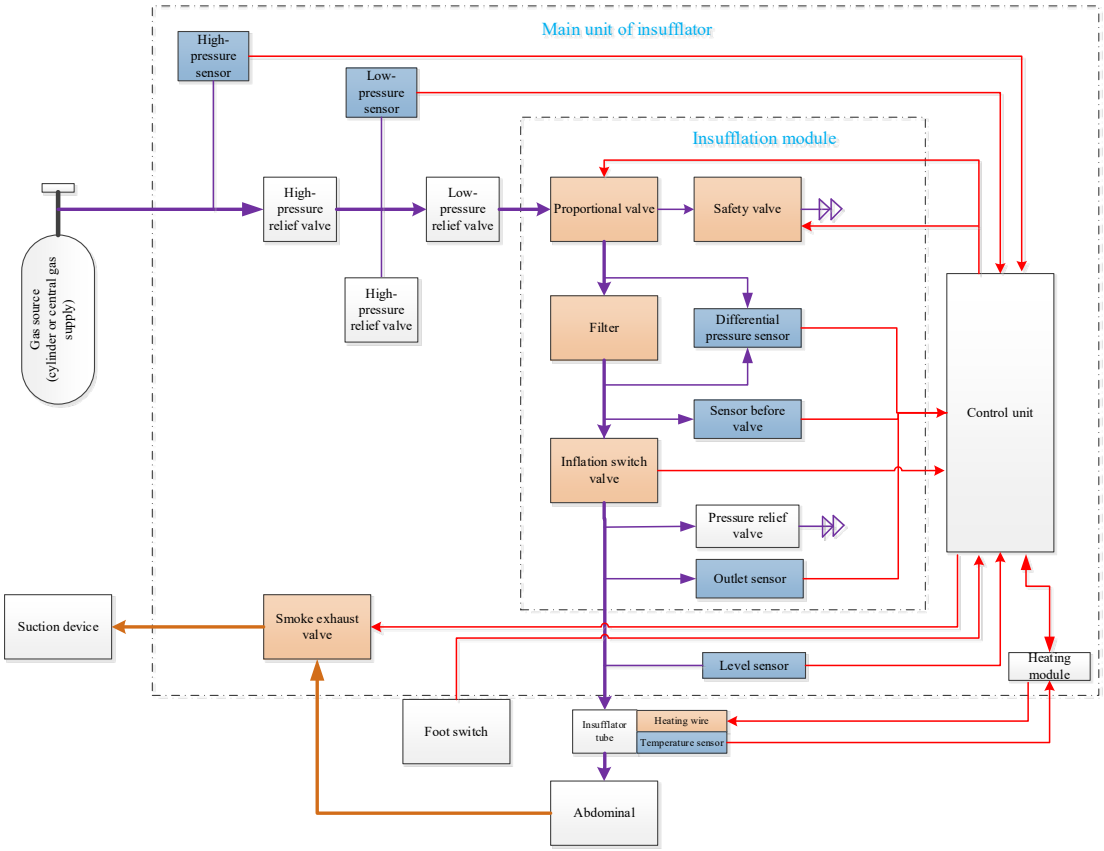


Figure 2-3 System Block Diagram of Insufflator

The insufflator adjusts and controls the flow and pressure. Thee flow adjustment range is 0.1-50 L/min, and the pressure adjustment range is 1-30 mmHg.

The flow rate is adjusted by a proportional valve, and the flow rate is detected by a sensor.

The pressure is obtained by the sensor.

External heating is realized through the insufflator tube.

The external suction device and the smoke exhaust valve of the insufflator jointly realize the smoke exhaust function.

The control unit is used for data collection, data processing, system control, etc.

2.3.2 System Structure

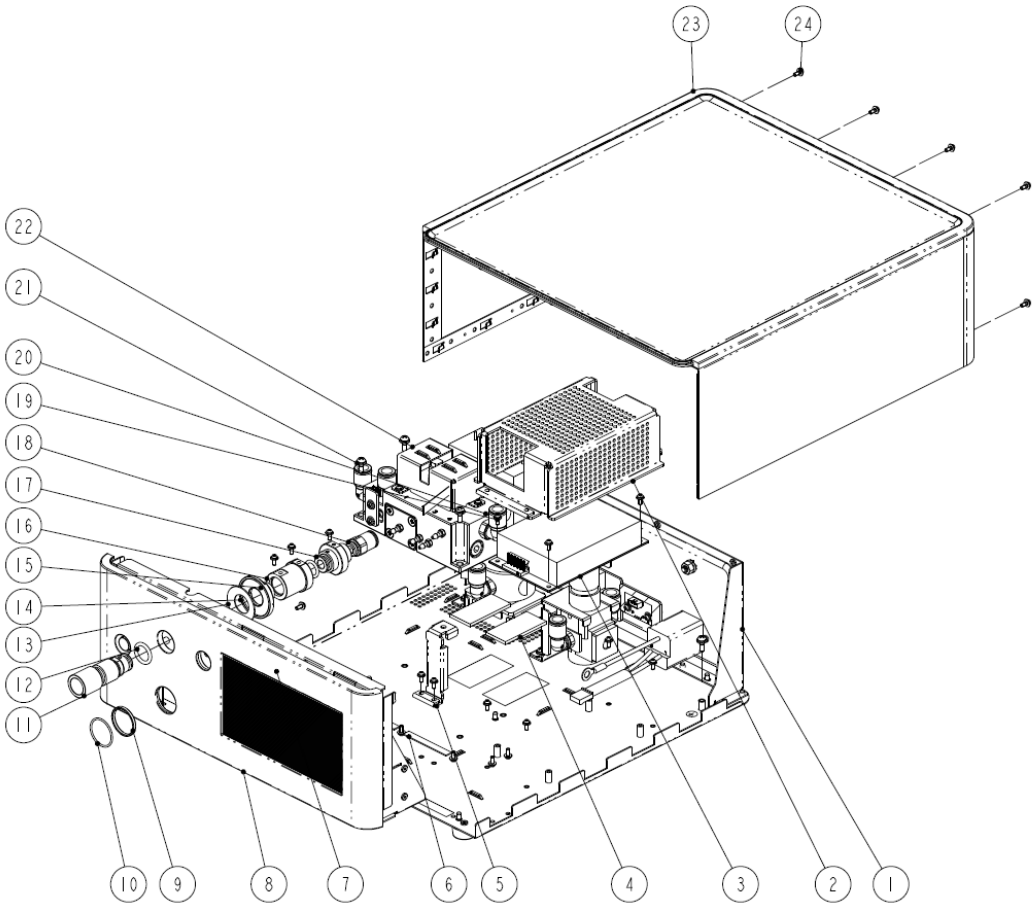


Figure 2-4 Mechanical Structure Diagram of Insufflator

No.	Part Code	Description
1	115-048986-01	Base plate assembly
2	042-022554-01	Power shielding box
3	022-000353-00	100-240VAC 12V 150W
4	045-000666-00	Thermal pad (52 mm × 25 mm × 3 mm)
5	042-026230-00	Pipeline support
6	024-000569-00	Conductive foam 1.0 mm × 7.0 mm
7	024-000569-00	Conductive foam 1.0 mm × 7.0 mm
8	115-047970-01	Front panel assembly
9	041-038542-00	Sealing spacer
10	082-003304-00	Sealing ring. O type 25×1.5 ethylene propylene rubber A70 black
11	041-029786-01	Insufflator tube connector
12	M6M-010062---	Sealing ring. O type 15X3 fluoro-rubber black A75
13	033-000314-00	Disc spring. 3rd series D=35.5

14	041-030286-01	Locking screw
15	082-003305-00	Sealing ring. O type 12X2.5 ethylene propylene rubber A70 black
16	041-030221-01	Insulating fixing base
17	041-030220-01	Conductive joint
18	082-000346-00	Joint. Straight plug G1/4 Φ10 trachea
19	M04-051140---	Small cross recessed pan head screw assembly GB/T9074.8 M3×8 plated with green color zinc
20	006-000352-00	CORE 18.5×14×6 Round
21	030-000098-00	Stainless steel cross recessed pan head screw GB/T9074.4 M4×12, passivated
22	115-047973-01	Pneumatic module
23	115-047968-00	Upper cover assembly
24	030-000099-00	Stainless steel cross recessed pan head screw GB/T9074.4 M3×8, passivated

Table 2-1 Mechanical Structure Diagram of Insufflator

2.3.3 Hardware System

The hardware system is shown in the figure below. It mainly includes the EMI filter, power supply module, insufflator main board, insufflator heating board, USB board, CAN connector board, network connector board, power button board & power-on indicator board, display & touch screen, and other peripherals.

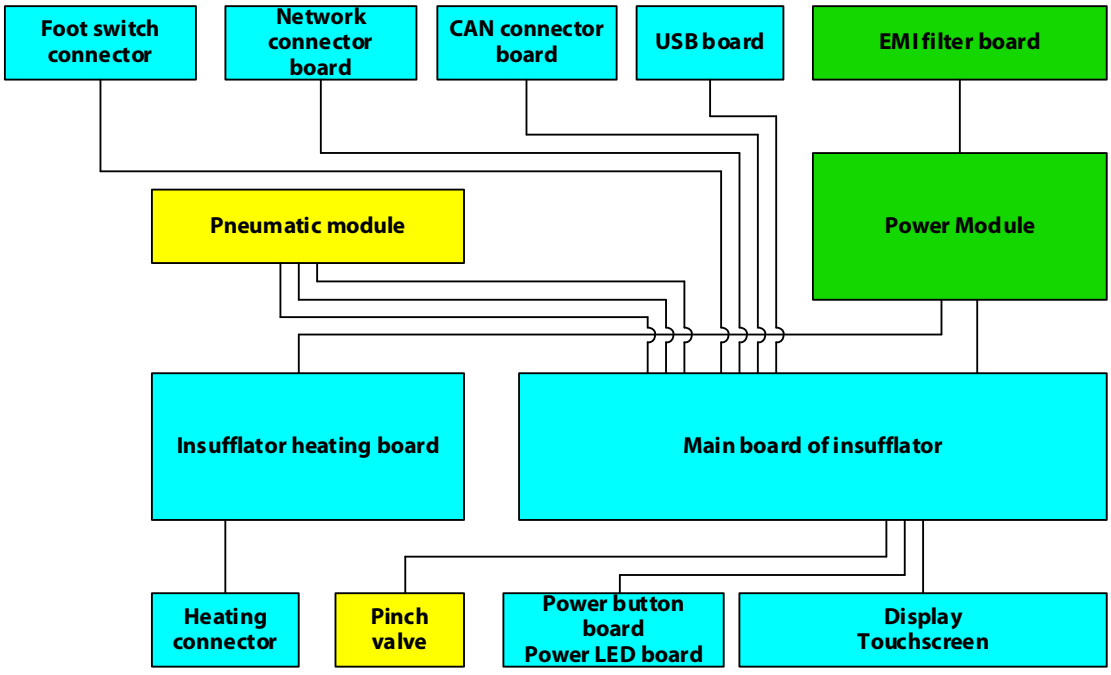


Figure 2-5 Hardware Principles

The power module is directly powered by the mains supply. The power generated by the power module passes through the EMI filter and powers the entire system.

The power keypad and power LED board detect and indicate the power-on status. An orange LED

represents that the equipment is connected to an AC source but not started, and a blue LED represents that the equipment is started.

The main board of the insufflator is the core of the whole system. It realizes the functions of human-computer interaction, flow control, pressure control, air volume calculation, smoke exhaust control, heating control, temperature measurement and liquid detection.

The main board of the insufflator heating board is used for voltage conversion and current monitoring, providing a stable voltage for the external heating of the insufflator tube and realizing overcurrent protection.

The network connector board, USB board, CAN connector board and foot switch connector provide extensive external connectors to facilitate communication with the insufflator.

3 Installation Guide

3.1 Preparations

3.1.1 Installation Environment

Refer to section 2.1.4Environment Information for the information about the installation environment. The information includes:

- Power supply: AC 100-240 V±10%; Frequency: 50/60 Hz±1 Hz.
- CO_2 gas source: pressure range 0.4-16 MPa.

3.1.2 Preparation of Accessories

Before installation, you need to prepare the following additional materials. The customer is responsible for providing this material. Any missing items may cause delays, incomplete installation and/or additional on-site services.

- Gas source connector or gas cylinder consistent with the purchased configuration.
- The gas source hose, pressure relief valves or high pressure pipe required for the product.
- Negative pressure suction device.

3.1.3 Preparation of Tools

The following tool is required for installation and testing:

- Scissors

3.2 Unpacking

1. When unpacking, make sure that the package is intact and undamaged. Otherwise, take and keep photographs of the damaged part.
2. Where there are no special requirements, just unpack and take the equipment and accessories out.
3. Check the items in the box against the packing list.
4. Check whether the main unit arrives intact and undamaged. Otherwise, take and keep photographs of the damaged part.
5. Check whether the Insufflator tube arrives intact and undamaged. Otherwise, take and keep photographs of the damaged part.

3.3 Installation Procedures

The main unit of the insufflator does not need to be installed. For the installation of accessories, please refer to section 4.1 of the manual.

3.4 Test After Installation

Calibration/test items after maintenance	Reference section in the Service Manual	Calibration/test completed
Visual integrity check	7.2	□
Power-on self-inspection	7.3	□
Ventilation function test	7.4.1	□
Heating function test (optional)	7.4.4	□
Smoke exhaust function test (optional)	7.4.5	□
Gas source detection function test	7.4.6	□

4 Equipment Maintenance

4.1 Maintenance Overview

Physical inspections, replacement of consumables, and performance inspections should be performed regularly according to the following maintenance cycle.

4.2 Maintenance Cycle

It is recommended that the maintenance cycle of the insufflator does not exceed 24 months.

4.3 Tools

The following tools are needed for regular maintenance:

- Insufflator maintenance tools (898-002454-00)
- Phillips screwdrivers
- Slot-type screwdrivers
- Hexagon wrench

4.4 Inspection and Calibration Before Maintenance

Check item	Required equipment	Reference section in the Service Manual	Calibration/test completed
Visual integrity check	No	7.2	□
Power-on self-inspection	No	7.3	□
Zero calibration of high pressure sensor	No	6.2	□
Zero calibration of flow and pressure sensors (for V2.0 insufflator only)	No	6.3	□
Stress Accuracy Test	Flowmeter	7.4.2	□
Flow accuracy test	Flowmeter	7.4.3	□
Heating function test (optional)	Heating tube	7.4.4	□
Smoke exhaust function test (optional)	Exhaust pipe	7.4.5	□
Gas source detection function test	No	7.4.6	□

4.5 Maintenance Kit Parts List

No.	Material code	Material description	Qty
1	115-063721-00	Filter repair spare parts	1
2	115-063725-00	Sensor connecting pipe repair spare parts	1
3	115-076020-00	Liquid inlet contamination repair spare parts	1
4	115-078501-00	Rubber hose. Precision soft PU hose 7 mm × 10 mm repair spare parts	1

4.6 Maintenance Procedure

1. Replace the components of the filter repair spare parts, including high-pressure sealing gasket, sealing ring, and pressure relief valve filter assembly. Refer to 9.2.
2. Remove the upper cover assembly. Refer to 9.1.
3. Replace the sensor connecting pipe repair spare parts. Refer to 9.20.
4. Replace the liquid inlet contamination repair spare parts. Refer to 9.21.

Replace the PU hose repair spare parts. Refer to 9.22.

4.7 Calibration and Testing After Maintenance

Calibration/test items after maintenance	Reference section in the Service Manual	Calibration/test completed
Flow calibration	6.4	□
Visual integrity check	7.2	□
Power-on self-inspection	7.3	□
Stress Accuracy Test	7.4.2	□
Flow accuracy test	7.4.3	□
Heating function test (optional)	7.4.4	□
Smoke exhaust function test (optional)	7.4.5	□
Gas source detection function test	7.4.6	□
Safety test	7.5	□

5 Troubleshooting

5.1 Maintenance Precautions

5.1.1 Safety Precautions

Before opening the insufflator for internal inspection and maintenance, be sure to turn off the insufflator, disconnect the power cord of the device, and disconnect the gas source.
If you need to perform related tests inside the insufflator after turning it on, such as disconnecting or connecting cables, or connecting or disconnecting probes, be sure to turn off the system power before operation. Otherwise, it may cause safety risks or equipment damage.

5.1.2 Troubleshooting Precautions

Before troubleshooting, please refer to the *Section 6.2 Fault Analysis and Troubleshooting* in the user manual to troubleshoot whether the fault is caused by user or accessory problem.
Before troubleshooting, first connect the gas source and power source, try to restart or run the insufflator, and check whether the fault remains. If the fault remains, follow section 5.3-5.5. If the fault disappears after restarting, the troubleshooting method does not apply, and you may replace all the suspected components in the Fault Cause column.

5.2 Tools

The following tools are needed for troubleshooting:

- Multimeter
- Insufflator maintenance tools (898-002454-00)
- Phillips screwdrivers
- Slot-type screwdrivers
- Hexagon wrench

5.3 Starting Problem Handling

Fault Symptom	Possible Cause	Confirmation of Fault Cause	Troubleshooting
The indicator light does not light up and the system is not started after the AC power supply is plugged in.	The fuse is blown.	The fault disappears after the fuse is replaced. You can also use the following method to determine: 1. The main board display light is off (see Figure 5-1). 2. Use a multimeter to measure the input voltage of the power supply module (see Figure 5-1). The power	Replace the AC outlet fuse. See section 9.21.

		supply module has no voltage output.	
	Power module failure	1. The main board indicator light (see Figure 5-1) is off. 2. Use a multimeter to measure the output terminal of the power supply module (see Figure 5-1). The output voltage is smaller than 10 V.	Replace the power supply module. See section 9.8.
	Poor connection of the power button board cable	1. The main board indicator light (see Figure 5-1) is off. 2. The fault disappears after the power button board connection cable is reconnected. See Figure 5-2.	Reconnect the power button board connection cable. See Figure 5-2 Host Interior-2.
	Power button board failure	The fault disappears after the power button board is replaced (see section 9.14).	Replace the power button board. See section 9.14.
	Main board failure	The fault disappears after the main board is replaced (see section 9.10).	Replace the main board. See section 9.10.
The indicator light is on, but the system is not started.	Main board failure	After the power button is pressed, the power indicator turns green.	Replace the main board. See section 9.10.
	Poor connection of the power button board cable	1. After the power button is pressed, the power indicator color remains the same. 2. The fault disappears after the power button board connection cable is reconnected (see Figure 5-2).	Reconnect the power button board connection cable. See Figure 5-2.
	Power button board failure	1. After the power button is pressed, the power indicator color remains the same. 2. The fault disappears after the power button board is replaced.	Replace the power button board. See section 9.14.
The screen is blank after booting, but there is a self-check sound.	Poor display cable connection	The fault disappears after the display cable is reconnected (see Figure 5-3).	Reconnect the display cable. See Figure 5-3.
	Display fault	The fault disappears after the display is replaced (see section 9.13).	Replace the display. See section 9.13.
There is a sound of gas leakage inside the machine	Poor connection of PU hose and air leakage	The fault disappears after the PU hoses in the machine is reconnected (see Figure 5-1).	Reconnect the PU hose with an insertion depth of about 20 mm.

after connecting the gas source	PU hose deformation	Pull out the PU hose (see Figure 5-1). The inserted part of the PU hose is obviously deformed and yellowed.	Replace the PU hose (see Figure 5-1).
	Leakage of high-pressure regulator assembly	Pull out the PU hose at the input end of the low-pressure regulator (see Figure 5-1). The bend is suffocated, and there is still leakage even when the gas source is connected.	Replace the high-pressure regulator assembly. See section 9.3.
	Leakage of low-pressure regulator assembly	Disassemble the PU hose at the input end of the pneumatic module assembly. Disassemble the PU hose at the input end of the low-pressure regulator and connect it to the inlet end of the gas source (see Figure 5-1). After connecting the gas source, the leakage disappears.	Replace the low-pressure regulator assembly. See section 9.5.
	Leakage of pneumatic module assembly	Other than leakage of the above-mentioned components	Replace the pneumatic module assembly. See section 9.6.

5.4 Self-inspection Problem Handling

Fault Symptom	Possible Cause	Confirmation of Fault Cause	Troubleshooting
The gas cylinder is directly connected to the steel pipe for gas supply: Low gas source pressure Gas Supply？	The gas source is not connected, or the gas source pressure is low.	Check the on-site gas source pressure. Check whether the gas cylinder's gas source pressure is lower than 1 MPa.	Connect a gas source with sufficient air pressure.
	The high-pressure sensor has a large zero drift or failure.	If the self-inspection problem remains when the gas source pressure is greater than 1 MPa, the high-pressure sensor is faulty.	1. Perform zero calibration of high pressure sensor (see section 6.2). 2. Replace the high-pressure regulator assembly (See section 9.3) if the problem remains.
Central gas supply or pressure relief valve is connected	The gas source is not connected, or the gas source pressure is low.	Check the on-site gas source pressure. Check whether the pressure of the central gas source	Connect a gas source with sufficient air

to the gas cylinder: Low gas source pressure Gas Supply？		is lower than 0.1 MPa.	pressure.
	Central gas supply or gas cylinders supply gas after passing through the pressure relieve valve, but the gas source type is set to cylinder.	1. Press the **Settings** menu to enter the setting page. Change the gas source type to **Central Air Supply**. Restart the machine and the problem disappears.	Press the **Settings** menu to enter the setting page. Change the gas source type to **Central Air Supply**. Restart the machine.
	Low regulation pressure of the pressure relief valve	1. Check whether the pressure of low-pressure gauge of the pressure relief valve is lower than 0.1 MPa. 2. Check whether the regulator knob of the pressure relief valve is loose. It is the low regulation pressure of the pressure relief valve if either 1 or 2 is confirmed.	Tighten the knob of the pressure relief valve clockwise to increase the output pressure of the pressure relief valve.
	Dual-gauge pressure relief valve is stuck	1. Check whether the pressure of low-pressure gauge of the pressure relief valve is lower than 0.1 MPa. 2. After loosening the pressure relief valve, re-tighten it. Repeat the operation 3~5 times. The problem disappears.	After loosening the pressure relief valve, re-tighten it. Repeat the operation 3~5 times.
	Dual-gauge pressure relief valve fault	If it is confirmed that the pressure relief valve is not stuck (the fault remains after re-tightening the pressure relief valve), loosen the pressure relief valve adjusting knob, remove the connecting hose of the pressure relief valve, and then slowly tighten the pressure relief valve knob to observe Whether there is gas output at the output port of the pressure relief valve. If there is no gas output, the pressure relief valve is faulty.	Replace the dual-gauge pressure relief valve.
	The high-pressure sensor has a large zero drift or failure (V1.0).	V1.0: If the fault disappears after upgrading the software (see 10) and zeroing of the high-pressure	1. V1.0 upgrading software of insufflator (10)

		sensor (see section 6.2), the fault can be determined.	2. Perform zero calibration of high pressure sensor (see section 6.2). 3. Replace the high-pressure regulator assembly (See section 9.3) if the problem remains.
	Short circuit or open circuit of the proportional valve (V1.0)	Unplug the proportional valve cable (see Figure 5-2) and measure the proportional valve resistance. If the resistance is less than 9Ω, or >20Ω, the valve is faulty.	Replace the pneumatic module assembly (see section 9.6).
	Drive failure of the main board proportional valve (V1.0)	If it is not a short-circuit or open-circuit fault of the proportional valve, then: do not connect the gas source, set the proportional valve current to 90 in the diagnostic mode (see 5.7.3.3). Touch the proportional valve after about 2 minutes. If it is not heated, the proportional valve is faulty.	Replace the main board (see section 9.10).
	Mechanical failure of the proportional valve (V1.0)	If it is not a drive failure of the main board, connect the gas source. Set the proportional valve current to 90 in the diagnostic mode and open the inflation valve (see 5.7.3.3). Touch the proportional valve after about 2 minutes. If the valve is heated with no flow at the gas injection port, the fault can be determined.	Replace the pneumatic module assembly (see section 9.6).
	The low-pressure sensor has a large zero drift or failure (V2.0 and above).	When the gas source type is central gas supply, if the gas source pressure is greater than 0.1 MPa, but this self-check error remains, the low-pressure sensor is faulty.	Replace the pneumatic module assembly (see section 9.6).
Contamination	Liquid enters the insufflator.	/	1. Replacement of the liquid inlet

			sensor repair spare parts for V1.0 (see 9.11, 9.10 and 9.6), and replacement of liquid inlet contamination repair spare parts for V2.0 (see section 9.11) 2. For V1.0, upgrade the software version to clear the pollution mark (see 10). For V2.0, enter software settings to clear the pollution mark (see 6.5)
Device Failure Error Code 1 Device Failure Error Code 3	A part of the gas remains inside the insufflator. A self-check error occurs after it is exhausted during the self-check process.	The problem disappears after insufflator is restarted and the gas source is connected.	Restart the insufflator after connecting the gas source.
	Sensor hose falls off.	Disassemble the upper cover (see section 9.1). Check whether the joints of the sensor silicone tube are well connected (see Figure 5-1 Host Interior-1).	Reconnect the dropped silicone tube (see Figure 5-1).
	The high-pressure sensor has a large zero drift.	In the cylinder gas supply mode, this error occurs when the gas source is not connected. V1.0: In the central gas supply mode, the fault disappears after upgrading the software (see 10) and zeroing the high-pressure sensor (see section 6.2).	1. V1.0 upgrading software of insufflator (10) 2. Perform zero calibration of high pressure sensor (see section 6.2). 3. Replace the high-pressure regulator assembly (See section 9.3) if the problem remains.
	The low-pressure sensor has a large zero drift (V2.0 and above).	In the central gas supply mode, this error occurs when the gas source is not connected.	Replace the pneumatic module assembly (see

			section 9.6).
	Short circuit or open circuit of the proportional valve	Unplug the proportional valve cable (see Figure 5-2) and measure the proportional valve resistance. If the resistance is less than 9Ω, or >20Ω, the valve is faulty.	Replace the pneumatic module assembly (see section 9.6).
	Drive failure of the main board proportional valve	If it is not a short-circuit or open-circuit fault of the proportional valve, then: do not connect the gas source, set the proportional valve current to 90 in the diagnostic mode (see 5.7.3.3 for V1.0, 5.8.9 for V2.0). Touch the proportional valve after about 2 minutes. If it is not heated, the proportional valve is faulty.	Replace the main board (see section 9.10).
	Mechanical failure of the proportional valve	If it is not a drive failure of the main board, connect the gas source. Set the proportional valve current to 90 in the diagnostic mode and open the inflation valve (see 5.7.3.3 for V1.0, 5.8.9 for V2.0). Touch the proportional valve after about 2 minutes. If the valve is heated with no flow at the gas injection port, the fault can be determined.	Replace the pneumatic module assembly (see section 9.6).
Device Failure Error Code 2 Device Failure Error Code 4	Short circuit of inflation valve and safety valve (failure of pneumatic module assembly)	Unplug the inflation valve and safety valve cable connector (see Figure 5-2), and measure the inflation valve and safety resistance. If the resistance value is smaller than 9 Ω or greater than 20 Ω, the fault is confirmed.	Replace the pneumatic module assembly (see section 9.6).
	Inflation valve, safety valve drive failure (main board failure)	If it is not a short-circuit or open-circuit fault of the solenoid valve, then: do not connect the gas source. After the "insufficient gas source" prompt and the **Menu** button appear, press the **Menu** button to enter the standby mode. Open the inflation valve	Replace the main board (see section 9.10).

		and safety valve (see 5.7.3.3 for V1.0, 5.8.9 for V2.0). Touch the inflation valve and safety valve after about 2 minutes. If they are not heated, the fault is confirmed.	
	Mechanical failure of inflation valve and safety valve (failure of pneumatic module assembly)	If it is not a main board failure, then: do not connect the gas source. After the "insufficient gas source" prompt and the **Menu** button appear, press the **Menu** button to enter the standby mode. Connect the gas source, connect the gas injection port to the flowmeter, and then set the proportional valve current to 90 in the diagnostic mode. Open the inflation valve (see 5.7.3.3 for V1.0, 5.8.9 for V2.0). If no flow can be detected at the gas injection port, the fault can be confirmed.	Replace the pneumatic module assembly (see section 9.6).
	Proportional valve leakage (failure of pneumatic module assembly)	1. Open the inflation valve in the diagnosis mode and observe that the flow rate of the flowmeter is not less than 0.5 L/min. 2. The following method can also be used to diagnose: In the shutdown state, connect the gas source, remove the silicone tube (Figure 5-2) connected to the 3# sensor on the main board, and connect it to the pressure gauge. The pressure of the pressure gauge gradually increases.	Replace the pneumatic module assembly (see section 9.6).
	High zero drift of the pressure sensor in front of the valve (main board failure)	Other than the above-mentioned fault	1. V1.0: upgrading software (10) 2. Replace the main board (see section 9.10) if the problem remains.
Device Failure Error Code 6	DPU self-inspection error	Main board failure	Replace the power module (see 9.10)
Device Failure	CPU initialization	Main board failure	Replace the main

Error Code 7	communication failure Voltage other than 12 V is out of range		board (see 9.10).
Device Failure Error Code 8	Open or shorted valve	Unplug the inflation valve, safety valve and smoke exhaust cable connector (see Figure 5-2), and measure the valve resistance. If the resistance value is smaller than 9 Ω or greater than 20 Ω, the fault is confirmed.	Replace the pneumatic module assembly (see section 9.6).
	Valve drive failure	If the valve is not open or shorted, the fault is confirmed.	Replace the main board (see section 9.10).
Device Failure Error Code 9 High-pressure sensor failure	High-pressure sensor cable is off	Confirm whether the high-pressure sensor cable is well connected (see Figure 5-3).	Reconnect the high-pressure sensor cable (see Figure 5-3).
	High-pressure sensor failure	1. Perform zero calibration of high-pressure sensor (see section 6.2). 2. If the problem disappears after the a new high-pressure sensor is installed on the main board, the fault is confirmed.	1. Perform zero calibration of high pressure sensor (see section 6.2). 2. Replace the high-pressure regulator assembly (See section 9.3) if the problem remains.
	Main board AD failure	If the problem remains after connecting the new high-pressure sensor, the fault is confirmed.	Replace the main board (see section 9.10).
Device Failure Error Code 10	Low-pressure sensor out of range (pneumatic module assembly)	Low-pressure sensor failure	1. Replace the pneumatic module assembly (see section 9.6). 2. Replace the pneumatic module assembly (see section 9.6) if the problem remains.
	Main board AD failure	If the problem remains after connecting the new low-pressure sensor, the fault is confirmed.	Replace the main board (see section 9.10).

Device Failure Error Code 11	Differential pressure sensor, valve front sensor, outlet sensor zero point out of range	Main board failure	Replace the main board (see section 9.10).
Buzzer not functioning	Buzzer or control circuit failure	Main board failure	Replace the main board (see section 9.10).
Liquid Sensor Error Device Failure Error Code 13	Level sensor cable is off or unconnected.	Confirm whether the level sensor cable is well connected (see Figure 5-2).	Reconnect the level sensor cable (see Figure 5-2).
Heat Module Error Heat Module Power Error Device Failure Error Code 15	Heating plate cable is not connected.	Check whether the heating plate cable is connected properly (see Figure 5-2).	Reconnect the heating plate cable (see Figure 5-2).
	Heating plate failure	If the failure disappears after replacing the heating plate, the fault is confirmed.	Replace the heating plate (see 9.15).

5.5 Operation Fault Handling

Fault Symptom	Possible Cause	Confirmation of Fault Cause	Troubleshooting
Gas Supply？	Refer to section 5.4.	Refer to section 5.4.	Refer to section 5.4.
Gas Exhausted?	The gas source is disconnected or the gas cylinder is exhausted, or the pressure relief valve is closed.	/	Replace the gas source with sufficient connection pressure, or increase the pressure of the pressure relief valve.
Contamination	Liquid enters the device.	/	Refer to section 5.4.
ERR#04	Failure of the proportional valve	Main board failure	Replace the main board (see section 9.10).
ERR#06	Power module failure	/	Replace the power supply module. See section 9.8.
ERR#07	Main board hardware failure	Main board failure	Replace the main board (see section 9.10).
ERR#08	Valve failure: The valve control state is inconsistent with the monitoring state.	Main board failure	Replace the main board (see section 9.10).

ERR#09	High-pressure sensor out of range	Refer to 5.4 Device Failure Error Code 9	Refer to 5.4 Device Failure Error Code 9
ERR#10	Low-pressure sensor out of range	Refer to 5.4 Device Failure Error Code 10	Refer to 5.4 Device Failure Error Code 10
ERR#11	Flow sensor and valve front pressure sensor (P2) out of range	Main board failure	Replace the main board (see section 9.10).
ERR#12 Sensor Error	V1.0: software fault	V1.0: If the fault disappears after upgrading the software, the fault is confirmed.	Upgrade software (10)
	Sensor silicone tube falls off or is bent.	Dissemble the upper cover (see 9.1) and check whether the sensor connecting pipe is disconnected or bent (see Figure 5-1).	Reconnect the sensor connecting pipe.
	Short circuit of inflation valve (failure of pneumatic module assembly)	Unplug the inflation valve cable connector, and measure the inflation valve resistance. If the resistance value is smaller than 9 Ω or greater than 20 Ω, the fault is confirmed.	Replace the pneumatic module assembly (see section 9.6).
	Inflation valve drive failure (main board failure)	If it is not a short-circuit or open-circuit fault of the solenoid valve, then: do not connect the gas source, open the inflation valve in the diagnosis mode (see 5.7.3.3 for V1.0, 5.8.9 for V2,0). Touch the inflation valve after about 2 minutes. If it is not heated, the fault is confirmed.	Replace the main board (see section 9.10).
	Mechanical failure of inflation valve (failure of pneumatic module assembly)	If it is not a main board failure, then: connect the gas source. Connect the gas injection port to the flowmeter, and then set the proportional valve current to 90 in the diagnostic mode. Open the inflation valve (see 5.7.3.3 for V1.0, 5.8.9 for V2.0). If no flow can be detected at the gas injection port, the fault can be confirmed.	Replace the pneumatic module assembly (see section 9.6).
	Pressure sensor failure (main board failure)	Other than the above-mentioned fault	Replace the main board (see 9.10).
ERR#13	Level sensor AD out of	Refer to 5.4 Device Failure Error	Refer to 5.4 Device

Liquid Sensor Error	range	Code 13	Failure Error Code 13
ERR#14	Heating sensor error (insufflator tube failure)	/	Replace the heating insufflator tube.
ERR#15 Heating plate failure Heat Module Error	Poor connection of the heating plate cable	The problem disappears after the heating plate cable is replaced (see Figure 5-2 Host Interior-2)9.15.	Reconnect the heating plate cable (see Figure 5-2 Host Interior-2).
	Heating plate failure	Not the heating plate cable fault	Replace the heating plate (see 9.15).
Insufflator tube not heated Heating plate power supply fault Heat Module Power Error	Insufflator tube failure	Replace the heating insufflator tube, the fault disappears.	Replace the heating insufflator tube.
	Poor connection of the heating plate cable	The problem disappears after the heating plate cable is replaced (see Figure 5-2 Host Interior-2)9.15.	Reconnect the heating plate cable (see Figure 5-2 Host Interior-2).
	Heating plate failure	Not the heating plate cable fault	Replace the heating plate (see 9.15).
Smoke exhaust function failed	Short circuit or open circuit of pinch valve	Unplug the smoke exhaust valve cable connector (see Figure 5-2 Host Interior-2), and measure the resistance. If the resistance value is smaller than 9 Ω or greater than 20 Ω, the fault is confirmed.	Replace the smoke exhaust valve (see 9.19).
	Main board drive failure	If it is not a short-circuit or open-circuit fault of the pinch valve, then: Open the pinch valve in the diagnosis mode (see 5.7.3.3 for V1.0, 5.8.9 for V2,0). Touch the pinch valve after about 2 minutes. If it is not heated, the fault is confirmed.	Replace the main board (see section 9.10).
	Pinch valve mechanical failure	If it is not a short circuit or open circuit fault of the pinch valve, then: Open the pinch valve in the diagnosis mode (see 5.7.3.3 for V1.0, 5.8.9 for V2.0). Touch the pinch valve after about 2 minutes. If it is heated, but cannot be opened, the fault is confirmed.	Replace the smoke exhaust valve (see 9.19).
Abnormal sound (large hissing sound when	Abnormal sound of low-pressure valve	Disconnect the gas source, connect the output gas source of the high-pressure valve directly to the	Replace the low-pressure valve (see 9.5).

inflating)		gas source inlet of the pneumatic module (see Figure 5-1 Host Interior-1), then connect the gas source to start inflating. The abnormal sound disappears	
	Abnormal sound of high-pressure valve	The abnormal sound comes from the high-pressure valve.	Replace the high-pressure valve (see 9.3).
Abnormal sound (abnormal intermittent sound during inflation)	Proportional valve fault	Do not connect the insufflator tube and start inflation in adult mode. The time of each inflation pulse is less than 2s.	Replace the pneumatic module assembly (see section 9.6).

5.6 Schematic Diagram of Fault Detection

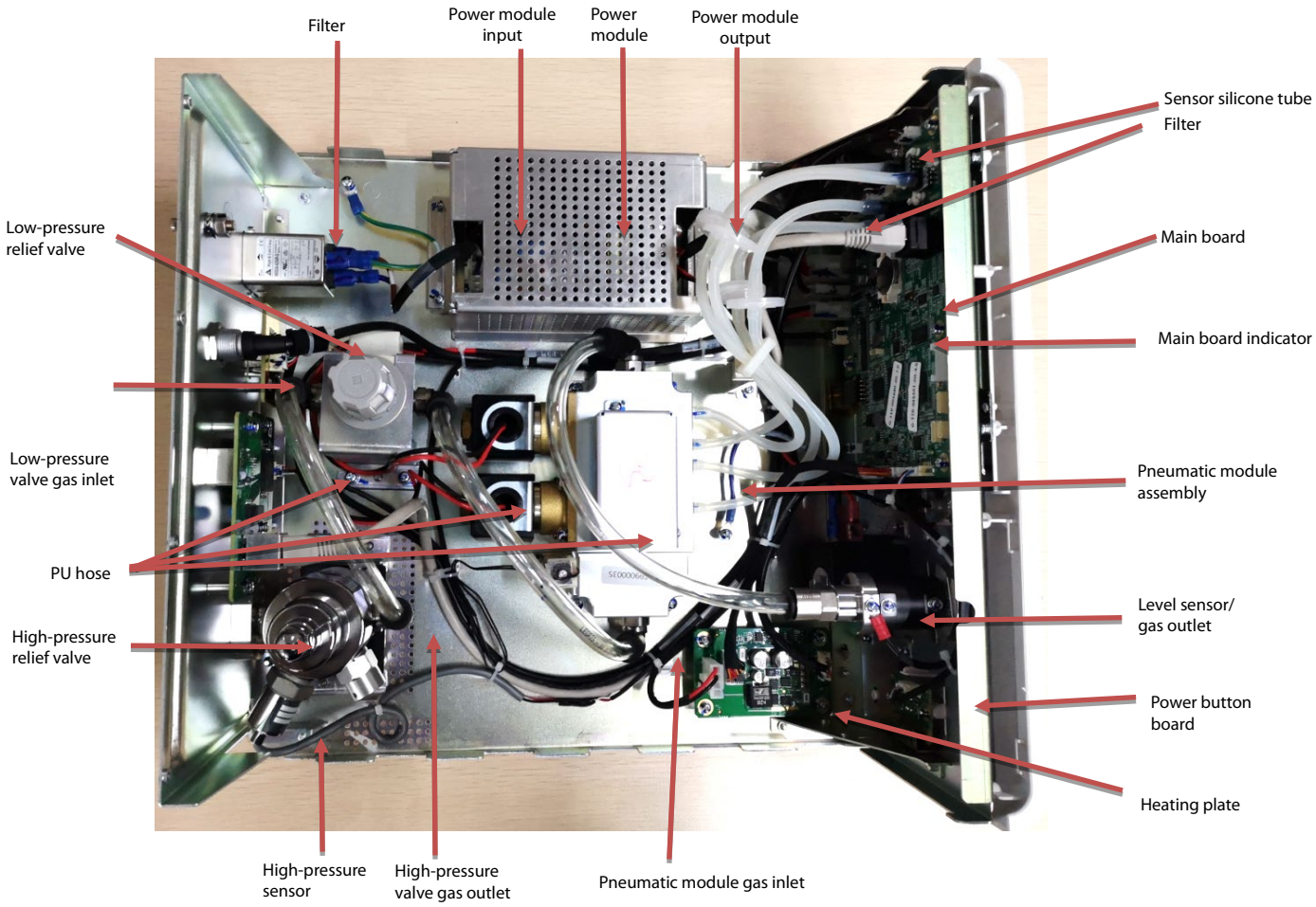


Figure 5-1 Host Interior-1

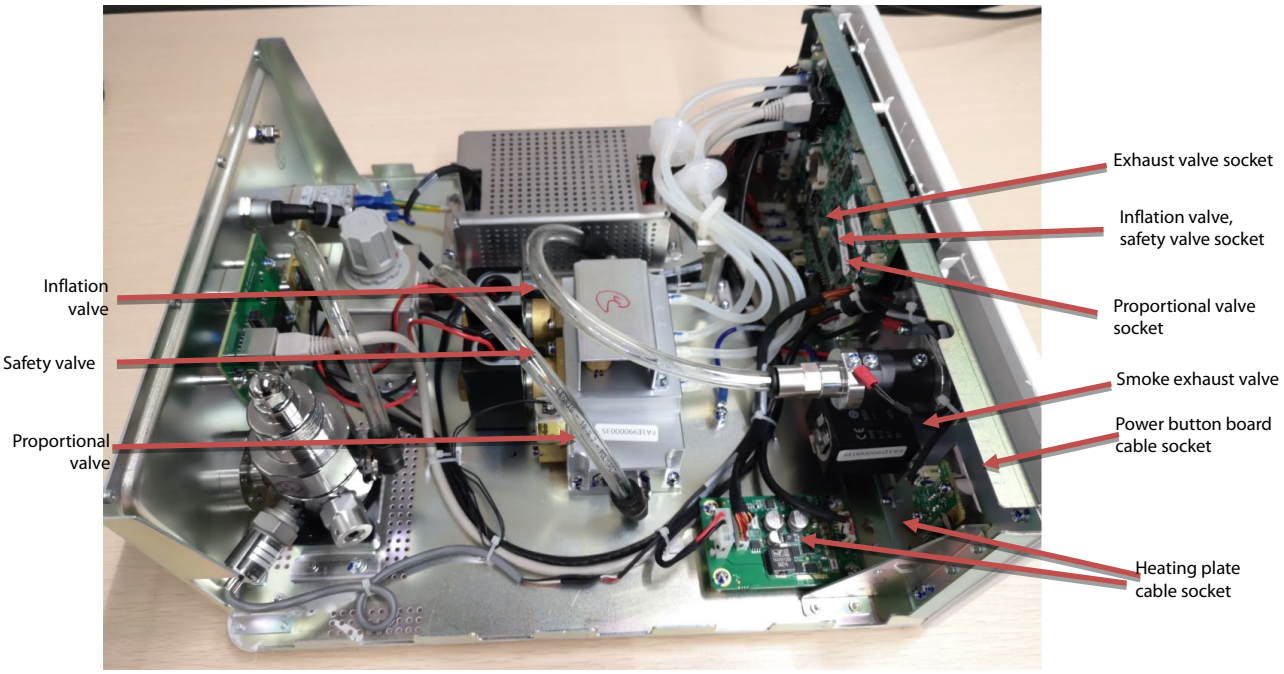


Figure 5-2 Host Interior-2

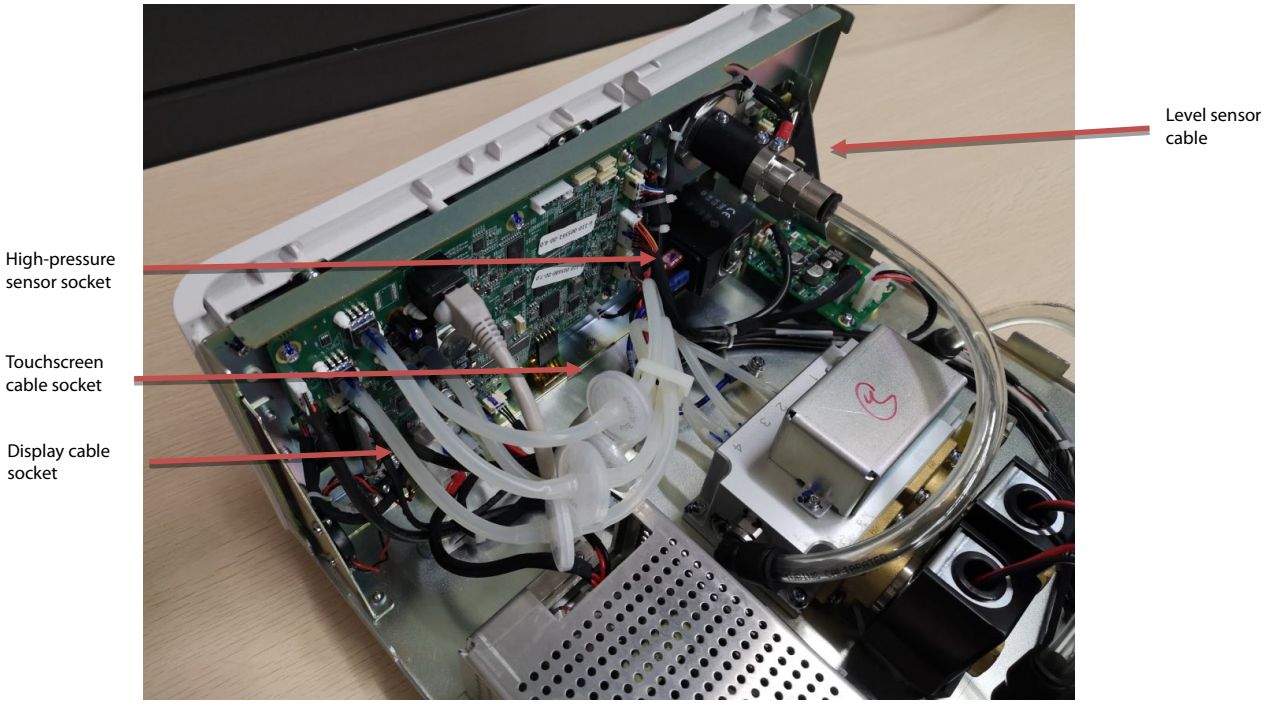


Figure 5-3 Host Interior-3

5.7 Manufacturer Maintenance Interface Description (Insufflator V1.0)

5.7.1 Setting Interface

Tap **Setting** on the home page to enter the setting interface. The setting interface is shown in the

following figure:

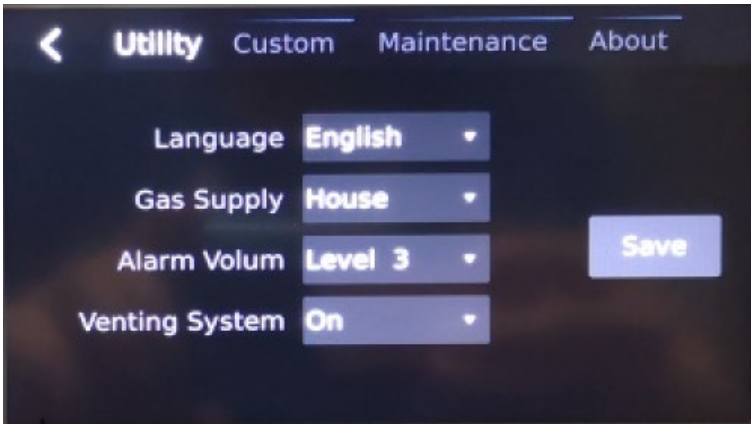


Figure 5-4 Setting Interface

On the setting interface, you can change the language, change **Gas Supply**, turn off or turn on the venting system. Tap the corresponding control, select the desired setting, and tap **Save** to complete the setting. The change will take effect after the machine is restarted.

5.7.2 Production Maintenance Interface

5.7.2.1 Entering the Production Maintenance Interface

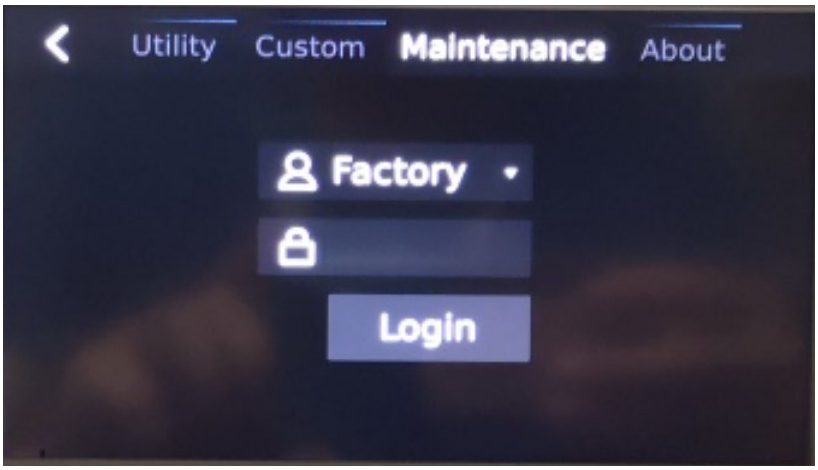


Figure -5 Production Maintenance Interface

1. In the standby mode, tap **Setting**, and select the **Maintenance** menu.
2. Select **Factory** in the selection box, enter the login password **7782**, and tap **Login** to enter the production maintenance interface.

5.7.2.2 Application

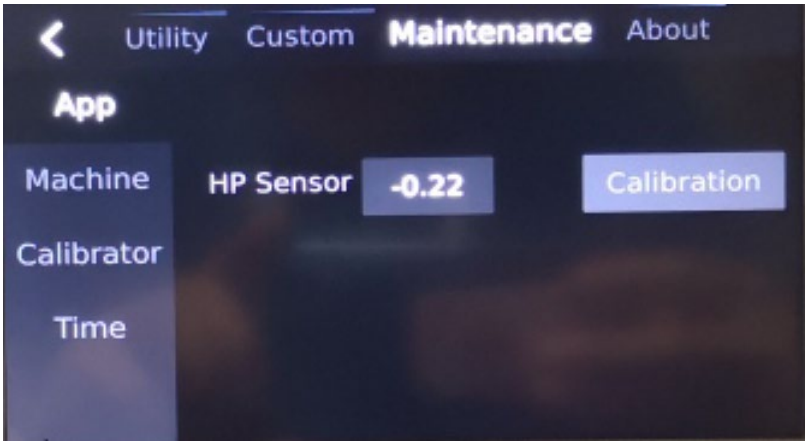


Figure 5-6 Factory-App Interface

In the **App** interface, you can zero the high-pressure sensor.

5.7.2.3 Model

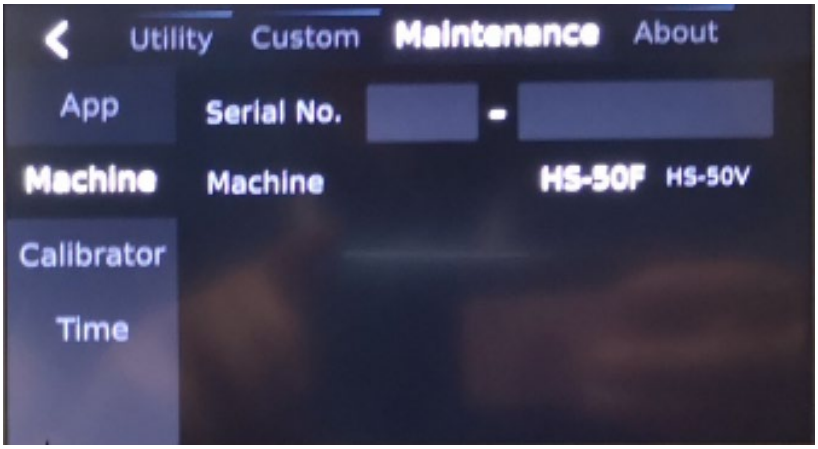


Figure 5-7 Production- Machine Interface

- In this interface, you can modify and edit the serial number of the machine.
- Tap the model identification and drag it to the left to select another model.

5.7.2.4 Flow Calibration

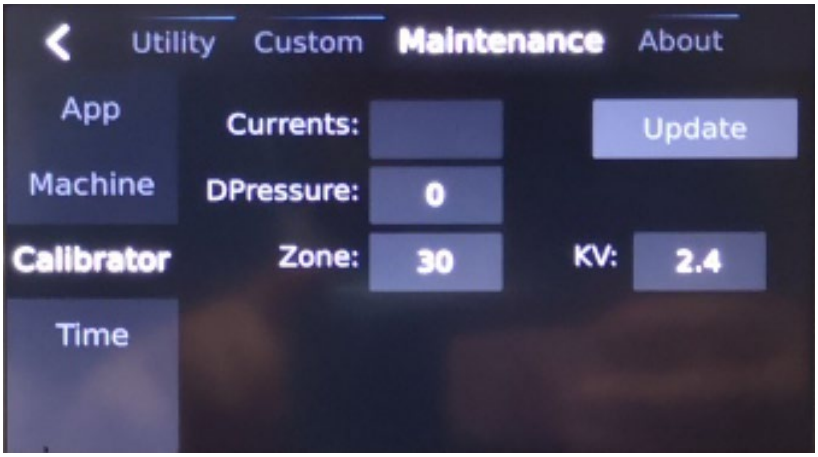


Figure 5-8 Factory-Calibrator Interface

In the flow calibration interface, you can perform flow calibration (including dead zone calibration and kv

value calibration).

5.7.2.5 Time

Figure 5-9 Factory- Time Interface

After tapping the control, you can modify the date and time, and tap **Apply** to make the change effective.

5.7.3 User Service Maintenance Interface

5.7.3.1 Entering the User Service Maintenance Interface

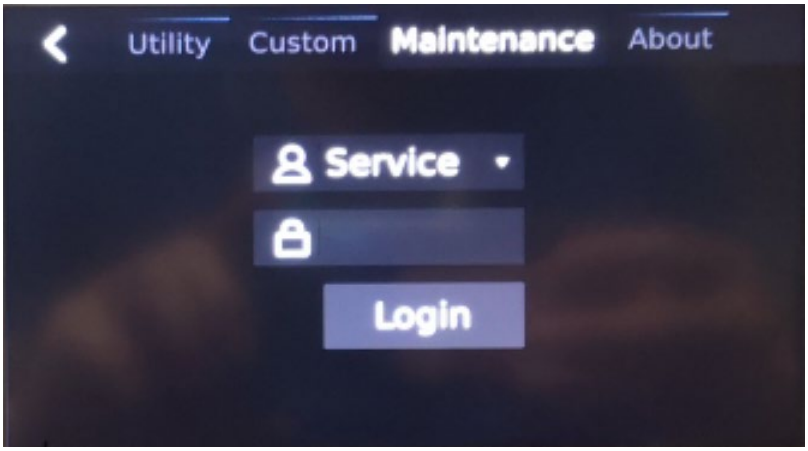


Figure 5-10 User Service Maintenance Interface

1. In the standby mode, tap **Setting**, and select the **Maintenance** menu.
2. Select **Service** in the selection box, enter the login password **8277**, and tap **Login** to enter the user service maintenance interface.

5.7.3.2 App

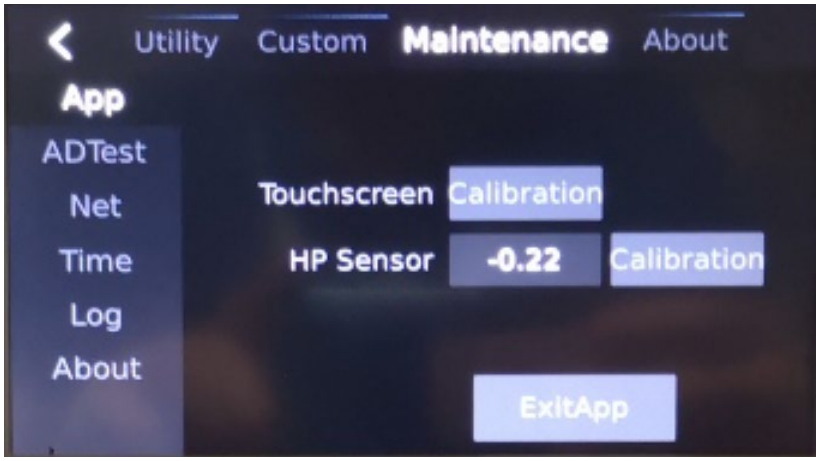


Figure 5-11 Service-App Interface

Tap **Calibration** on the touch screen to calibrate the touch screen.

Tap **Calibration** of the HP sensor to zero the high-pressure sensor.

5.7.3.3 AD Test

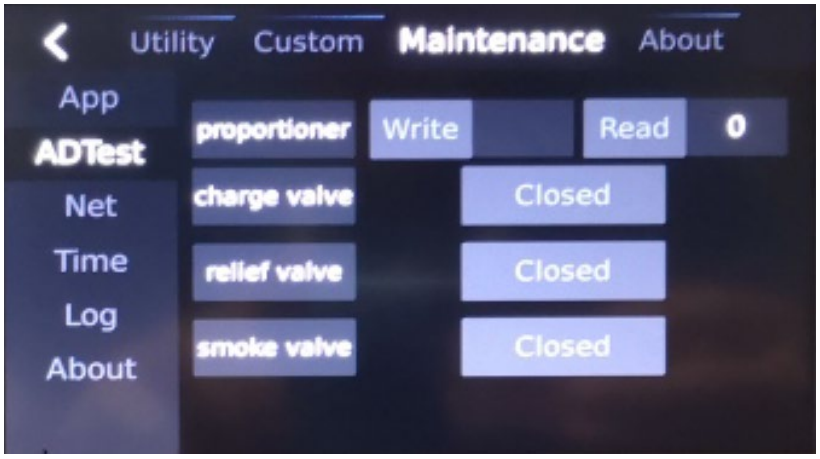


Figure 5-12 Service-AD Test Interface

Set the proportional valve current: On the AD test page, enter the proportional valve current and tap **Write** to modify the proportional valve current, and tap **Read** to read the proportional valve current.

Solenoid valve opening and closing control: Tap **Closed** to the right of the inflation valve, pressure relief valve or smoke exhaust to open the corresponding solenoid valve. After the solenoid valve is opened, tap the corresponding **Open** button to close the corresponding solenoid valve.

5.7.3.4 Time

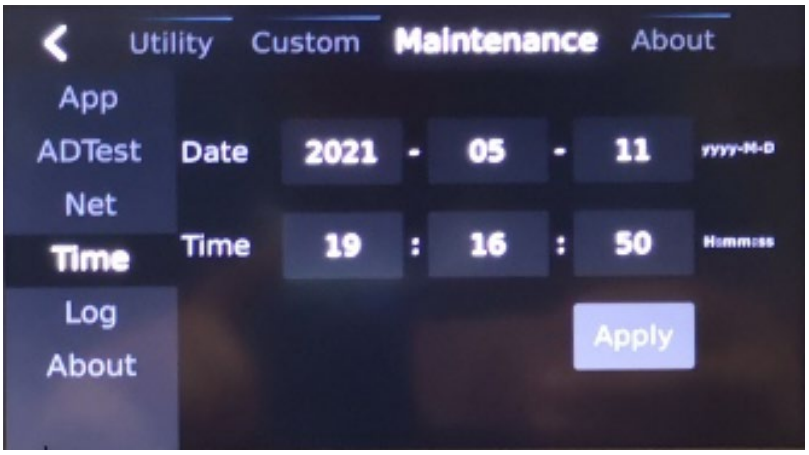


Figure 5-13 User Service- Time Interface

After tapping the control, you can modify the date and time, and tap **Apply** to make the change effective.

5.7.3.5 LOG

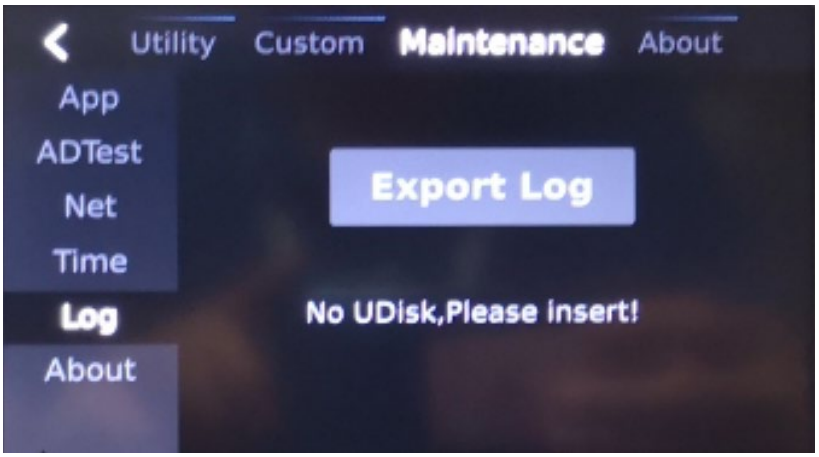


Figure 5-14 Service- LOG Interface

The log export interface is as shown in the figure above. If the flash drive is not inserted, it will display "No UDisk, please insert!". After the flash drive is inserted, when the interface displays "Flash drive is available", tap the **Export Log** control to export logs to the flash drive.

Refer to the autonomous ordering process of the company GP purchase for the selection of the flash drive. Choose a 16 GB or 32 GB USB2.0 flash drive. USB3.0 flash drive is not supported.

5.7.3.6 About

It shows detailed version information of the machine. If the machine fails, you need to record the information displayed on this page before service maintenance.

5.8 Manufacturer Maintenance Interface Description (Insufflator V2.0)

5.8.1 Setting Interface

Tap **Setting** on the home page to enter the setting interface. The setting interface is shown in the following figure:

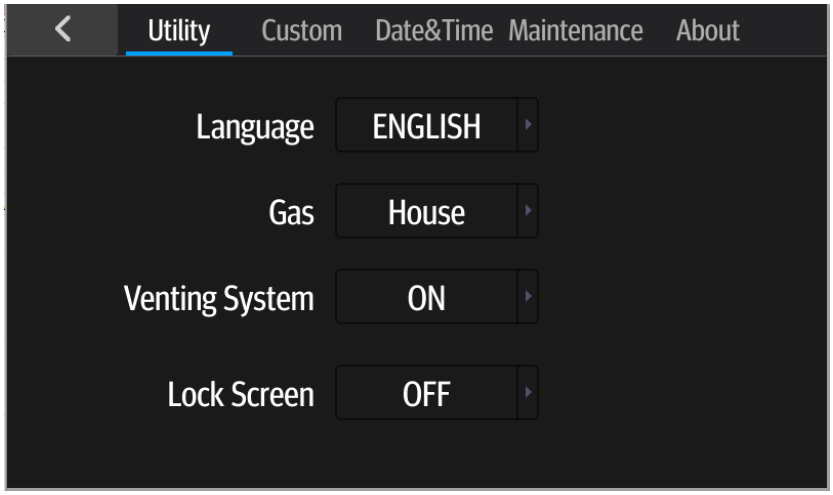


Figure 5-15 Setting Interface

On the setting interface, you can change the language, change the gas supply type, turn off or turn on the Venting System, turn off or turn on the Lock Screen. Tap the corresponding control, and select the desired setting.

5.8.2 Date and Time Setting Interface

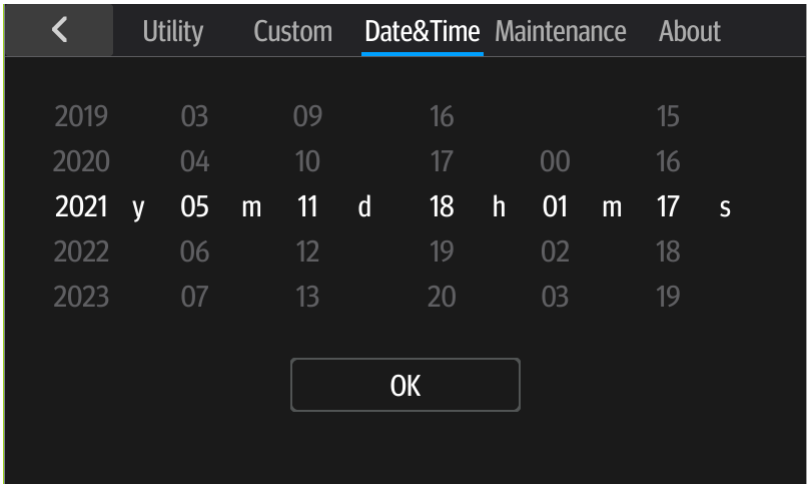


Figure 5-16 Date and Time Settings Interface

Select the current date and time and tap **OK** to save the settings.

5.8.3 Entering the Manufacturer Maintenance Interface

Tap **Maintenance** on the setting page to enter the **Maintenance Interface**. The page is shown in the following figure:

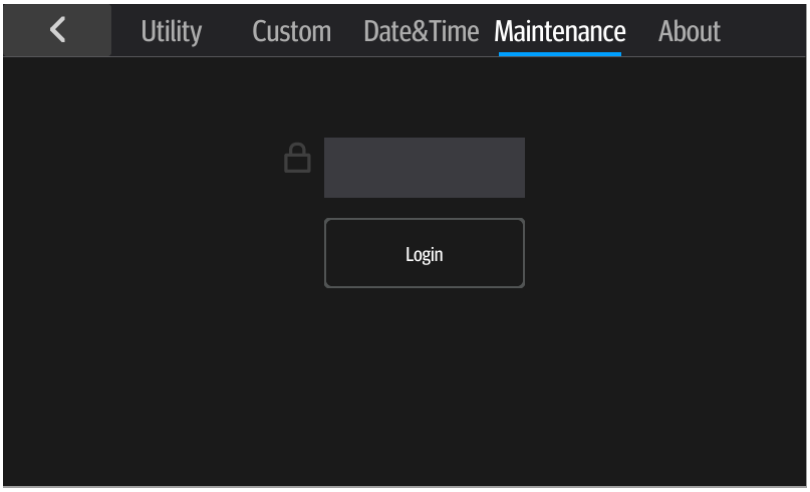


Figure 5-17 Maintenance Interface

After entering the login password "332888", you can log in to the **Maintenance Interface.**

5.8.4 System Information

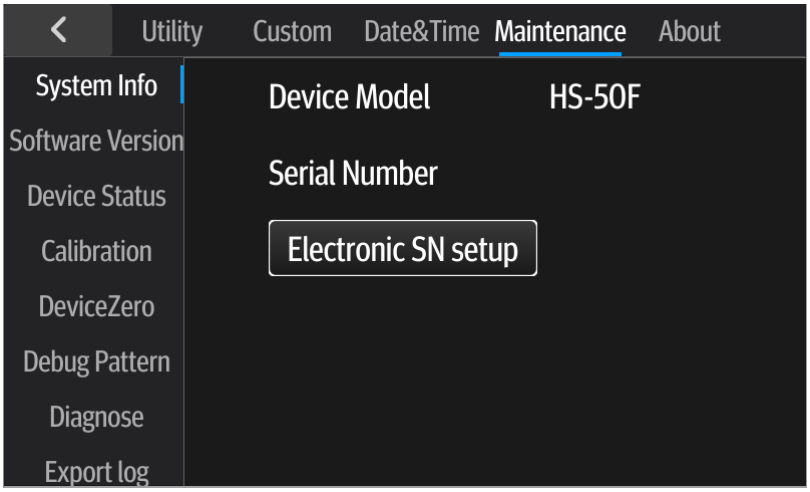


Figure 5-18 System Information Interface

The system information interface displays the device model (the device model cannot be set. If you need to change the model, you need to upgrade the software and select the software package of the corresponding model).

Tap **Electronic SN setup** to edit the device serial number and exit the manufacturer maintenance (tap **<** in the upper left corner) to save the change.

5.8.5 Software Version

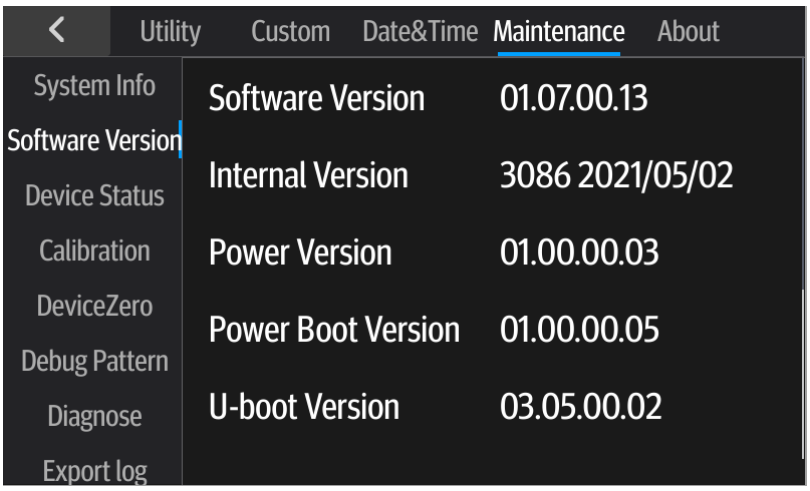


Figure 5-19 Software Version Interface

In this interface, you can view the detailed version information of the insufflator. You can scroll up to view the multi-version information.

5.8.6 Device Status

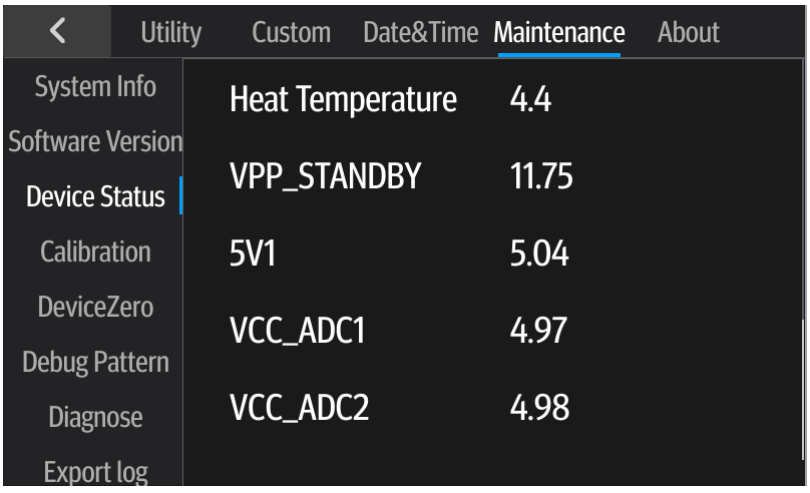


Figure 5-20 Device Status Interface

In the device status interface, you can view the real-time temperature of the heating insufflator tube and the real-time voltage of each power supply. You can scroll up to see more information.

5.8.7 Calibration Function

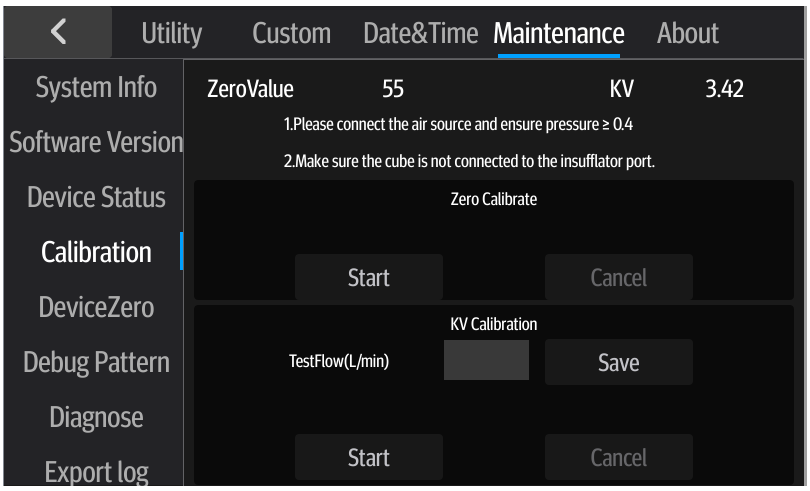


Figure 5-21 Calibration Function Interface

In this interface, you can perform the flow calibration function.

After preparation according to the above prompt, tap **Start** in the dead zone calibration area. The insufflator will automatically perform the dead zone calibration function. The automatic calibration function takes about 30-60s. The equipment will cancel the calibration if you tap **Cancel**. The equipment will return to the dead zone value before calibration.

After preparation according to the above prompt, connect the flowmeter and the gas injection port of the insufflator, tap **Start** of KV calibration. The insufflator will start the flow calibration. After the measured value of the flowmeter is stable, enter the measured flow value (in L/min) in the test flow edit box, and then tap **Save** to complete the KV value calibration.

5.8.8 Device Zero

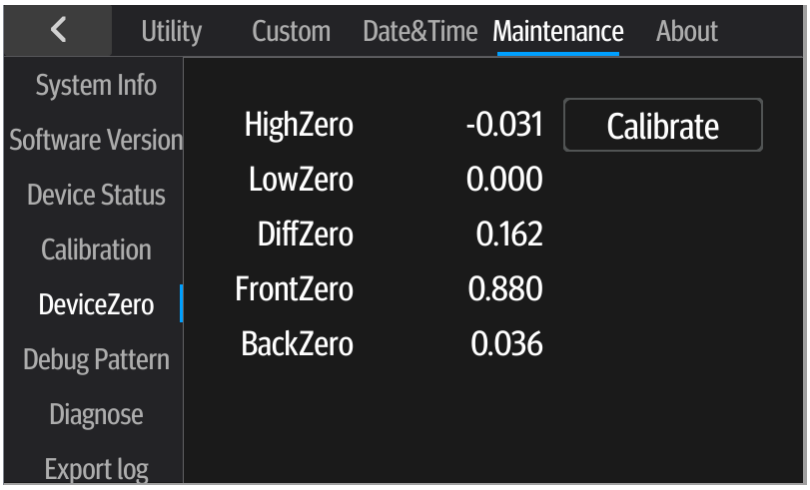


Figure 5-22 Device Zero Interface

In this interface, you can view the zero information of the equipment and the zero calibration of the high-pressure sensor.

Disconnect the gas source of the insufflator, and tap Calibrate to complete the zero calibration of the high-pressure sensor.

5.8.9 Diagnosis Function

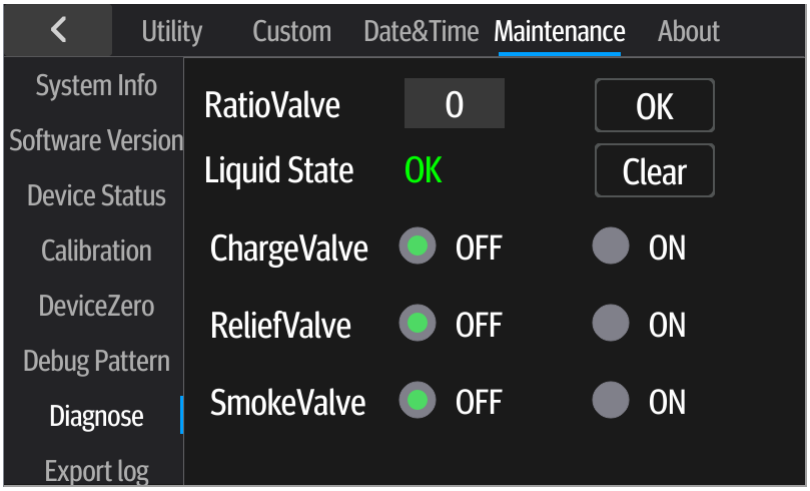


Figure 5-23 Diagnosis Function Interface

Set proportional valve PWM: In the proportional valve input box, enter the proportional valve PWM and tap **OK** to set the proportional valve PWM.

Liquid entering state removal: If the equipment is contaminated, after the parts are replaced, tap **Clear** to clear the contamination mark of the equipment.

Solenoid valve opening and closing control: Select **OFF** or **ON** on the right side of the inflation valve, pressure relief valve or smoke exhaust to open or close the corresponding solenoid valve.

5.8.10 Export Logs

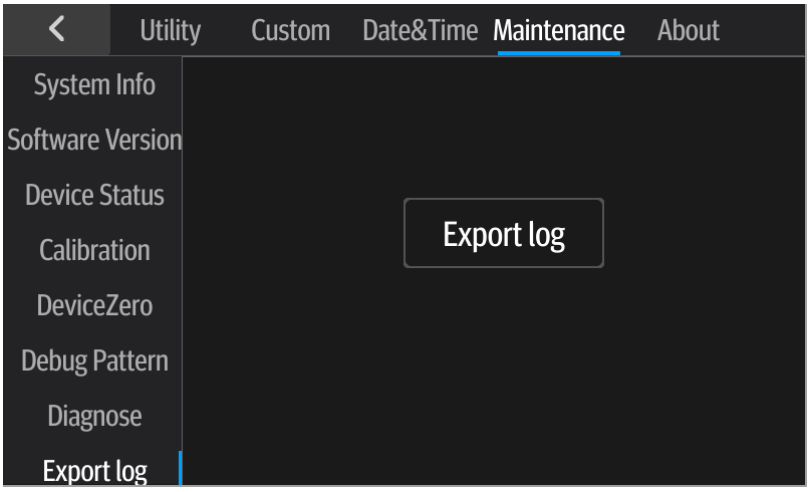


Figure 5-24 Log Export Interface

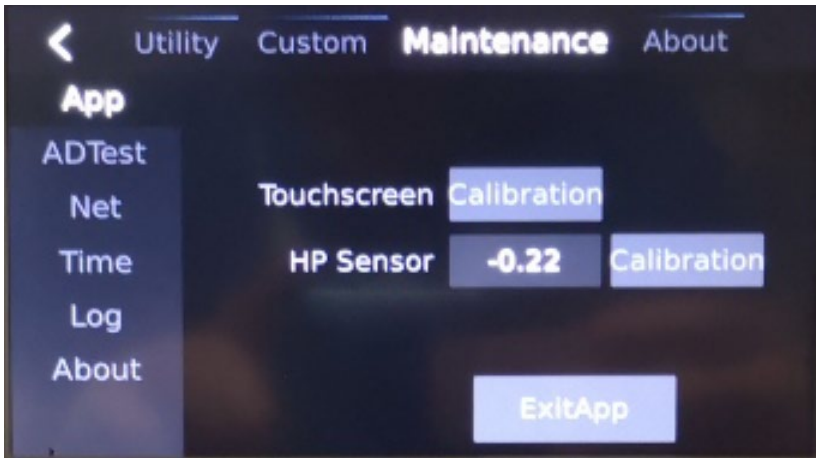
The log export interface is as shown in the figure above. After the flash drive is inserted, when the interface displays "Flash drive is available", tap **Export Log** to export logs to the flash drive.

6 Calibration

6.1 Touchscreen Calibration

Only insufflator V1.0 needs to perform touchscreen calibration after the touchscreen or motherboard is replaced, or software is upgraded.

1. After the upgrade, it will automatically enter touchscreen calibration when it is started for the first time after the upgrade. You can follow 5.7.2.2 to enter the factory maintenance interface, select the **Application** page, and then tap the **Touchscreen Calibration** button to enter the touchscreen calibration.



2. Tap the **Calibration** control on the screen. There will be five cross points on the upper left, upper right, lower right, lower left and middle of the screen. Please tap the center of the cross points exactly, as shown in the figure below.

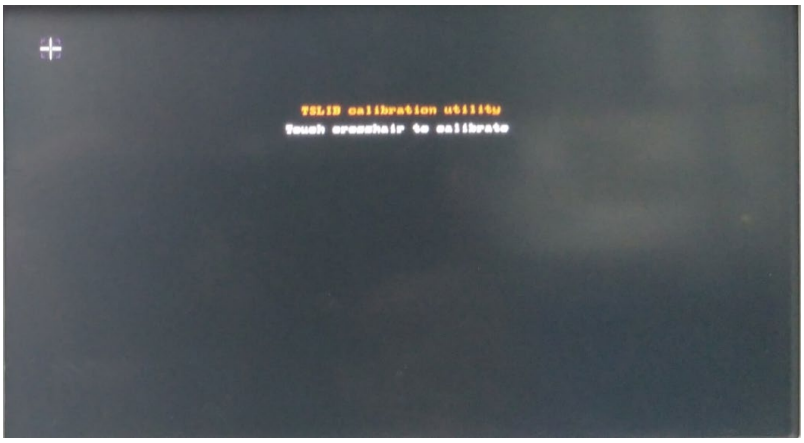


Figure 6-1 Touchscreen Calibration-Upper Left

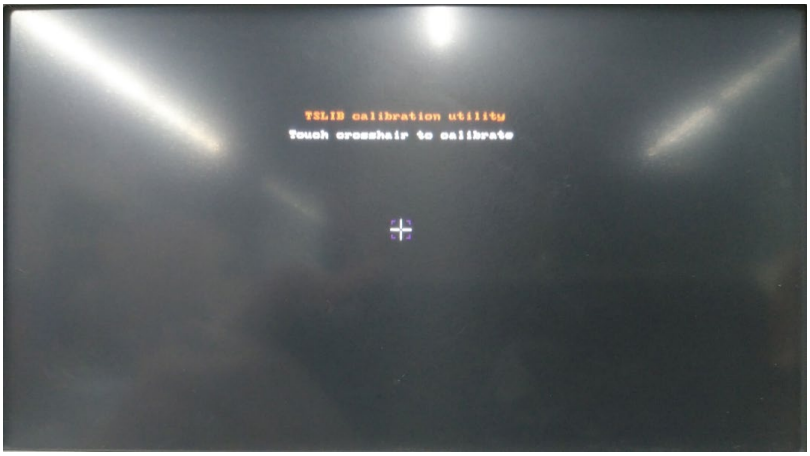


Figure 6-2 Touchscreen Calibration-Center

When the middle position is tap, the following prompt will appear on the screen:

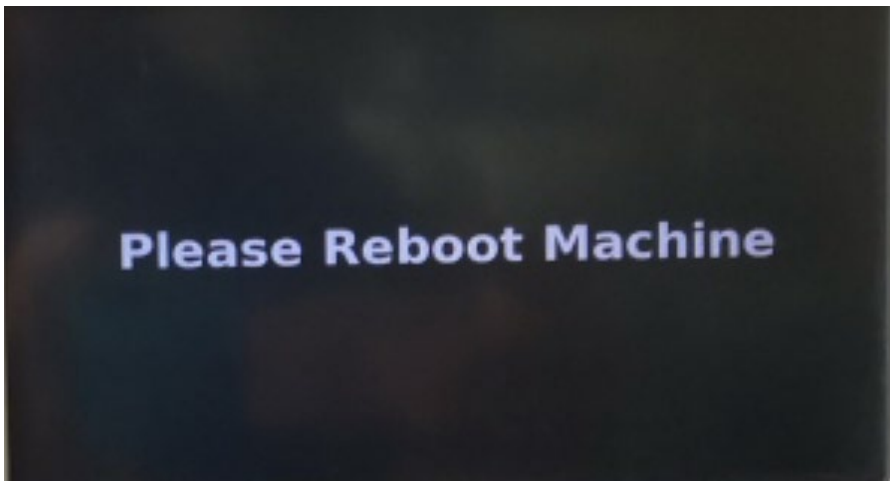


Figure 6-3 Touchscreen Calibration-Completed

The calibration process is now complete.

6.2 High-Pressure Sensor Calibration

6.2.1 Calibration Principle

High-pressure sensor calibration only zeros the high-pressure sensor. When the gas source is disconnected, the monitoring value of the high-pressure sensor is the zero point of the sensor.

6.2.2 Tools

/

6.2.3 Calibration Procedure

6.2.3.1 Calibration Procedure for High-Pressure Sensor of Insufflator V1.0

1. Ensure that the gas source of the insufflator is disconnected.

2. Follow 5.7.2.2 to enter the service maintenance interface.
3. In the service maintenance interface, select the App page and tap the Calibration button of the HP sensor. The zero point of the high-pressure sensor will be automatically refreshed, and the high-pressure sensor calibration can be completed.

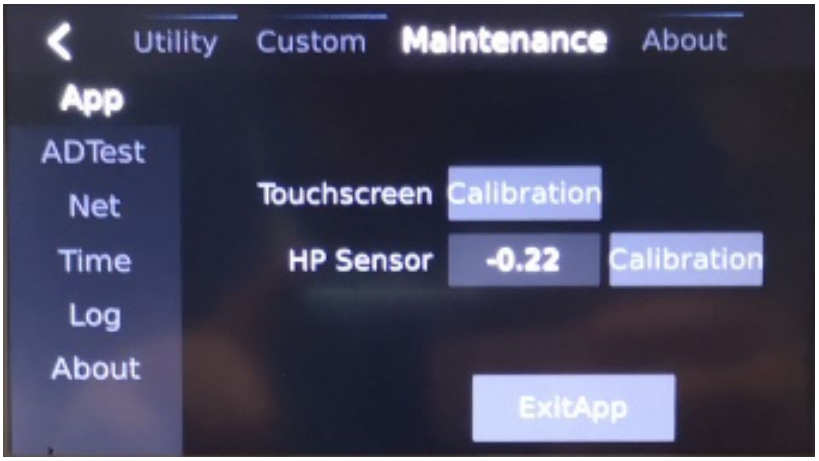


Figure 6-4 Calibration for High-Pressure Sensor of Insufflator V1.0

6.2.3.2 Calibration Procedure for the High-Pressure Sensor of the Insufflator V2.0

1. Ensure that the gas source of the insufflator is disconnected.
2. Enter the maintenance interface (see 5.8.2).
3. In the maintenance interface, select the **Device Zero** page and tap **HighZero Calibration**. The zero point of the high-pressure sensor will be automatically refreshed, and the high-pressure sensor calibration can be completed (see 5.8.8).

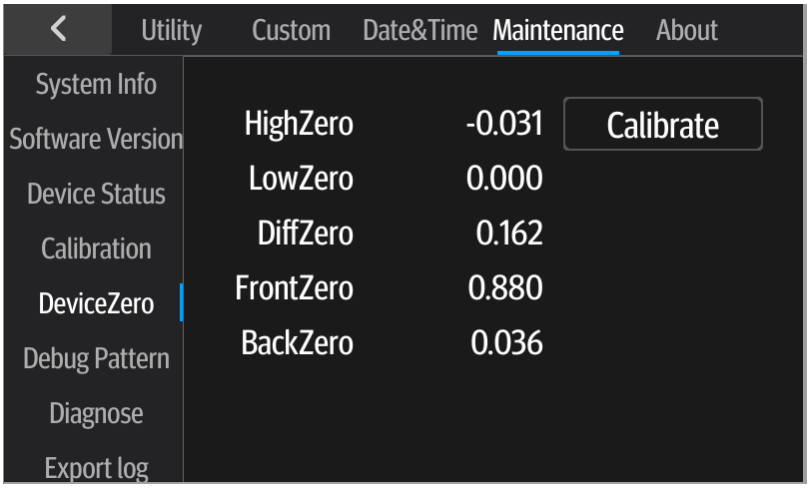


Figure 6-5 Calibration for High-Pressure Sensor of Insufflator V2.0

6.3 Zero Calibration of Flow and Pressure Sensors

1. Connect the gas source to the insufflator to ensure that the pressure of the gas source is not less than 0.1 MPa. Ensure that the gas injection port of the insufflator is not connected to the gas tube or filter.
2. Start or restart the insufflator.
3. After the insufflator is successfully completed, the zero calibration of the flow and pressure sensors can be completed.

6.4 Flow Calibration

6.4.1 Calibration Principle

Dead Zone Calibration

The dead zone is the critical point of the proportional valve's control current. If the current ratio exceeds this current ratio, it will open and output flow. If the current is less than this current, it will be closed with no flow output. The principle of dead zone calibration is to gradually increase the proportional valve to the current (or PWM duty cycle), and monitor the output gas flow of the proportional valve. When the output flow of the proportional valve is monitored, the current (or PWM duty cycle) is the dead zone of the proportional valve.

KV calibration:

The KV value refers to the flow rate/pressure difference ratio of the differential pressure meter in the flow sensor (used as a filter for generating the pressure difference). After this KV value is obtained, the equipment flow can be calculated by the formula: flow = KV * differential pressure. Since the KV value of the differential pressure meter (filter) used by the insufflator has better linearity, you only need to test the pressure difference and the actual flow rate at one point, and use the formula KV=actual flow/pressure difference to obtain the KV value.

6.4.2 Tools

Insufflator maintenance tools (898-002454-00)

6.4.3 Dead Zone Calibration

6.4.3.1 Dead Zone Calibration for Insufflator V1.0

1. Connect the gas source and ensure that the gas source pressure is not less than 0.4 MPa.
2. Follow 5.7.2.1 to entering the factory maintenance interface.
3. Select the **Calibrator** menu to enter the flow calibration page.

1. Enter the initial value of current as **20**, and tap the **Update** button.
2. If the displayed value of "Dpressure " is less than 0.1, increase the current value by +1 each time

and tap **Update** until the displayed Dpressure is greater than or equal to 0.1.

3. Enter the current value into the dead zone input box.
4. Exit the factory maintenance page to complete the dead zone calibration.

6.4.3.2 Dead Zone Calibration for Insufflator V2.0

1. Connect the gas source and ensure that the gas source pressure is not less than 0.4 MPa.
2. Enter the maintenance interface (see 5.8.2), select the **Calibration** page to enter the calibration interface.
3. On the **Calibration** page, tap the **Start** button in the dead zone calibration area, and the insufflator will automatically perform the dead zone calibration function. The automatic calibration function takes about 30-60s. The equipment will cancel the calibration if you tap **Cancel**. The equipment will return to the dead zone value before calibration.

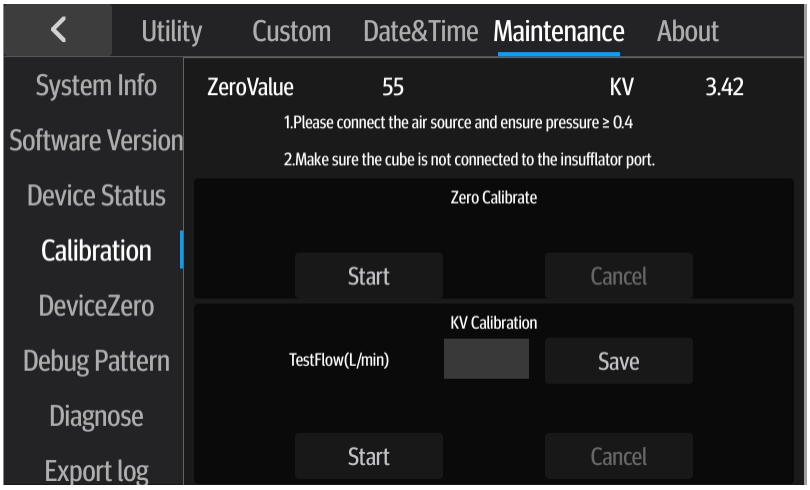


Figure 6-6 Dead Zone Calibration

Note: If the dead band is calibrated to 9 or 10, repeat step 3 to re-calibrate.

6.4.4 KV Value Calibration

6.4.4.1 KV Value Calibration for Insufflator V1.0

1. Connect the gas source and ensure that the gas source pressure is not less than 0.4 MPa.
2. Connect the gas outlet of the insufflator and the flow test device (the flow unit of the flow device is set to **ACT L/min**, and the gas type is **CO2**. For the flowmeter setting instructions, see Appendix A).

Figure 6-7 KV Value Calibration

3. Follow 5.7.2.1 to entering the factory maintenance interface.
4. Select the Calibrator menu to enter the flow calibration page.

5. Enter the initial value of current as **93**, and tap the **Update** button.
6. Observe the flow of the flow tester, calculate the KV value (KV=flow/pressure difference), and enter the obtained KV value.
7. Exit the factory maintenance page to complete the KV value calibration.

6.4.4.2 KV Value Calibration for Insufflator V2.0

1. Connect the gas source and ensure that the gas source pressure is not less than 0.4 MPa.
2. Connect the gas outlet of the insufflator and the flow test device (the flow unit of the flow device is set to **ACT L/min**, and the gas type is **CO2**. For the flowmeter setting instructions, see Appendix A).

Figure 6-8 KV Value Calibration

3. Enter the maintenance interface (see 5.8.2), select the **Calibration** page to enter the calibration interface.
4. In the Calibration Function interface, after preparation according to the above prompt, connect the flowmeter and the gas injection port of the insufflator, tap **Start** of KV calibration. The insufflator will start the flow calibration. After the measured value of the flowmeter is stable, enter the measured flow value (in L/min) in the test flow edit box, and then tap **Save** to complete the KV value calibration.

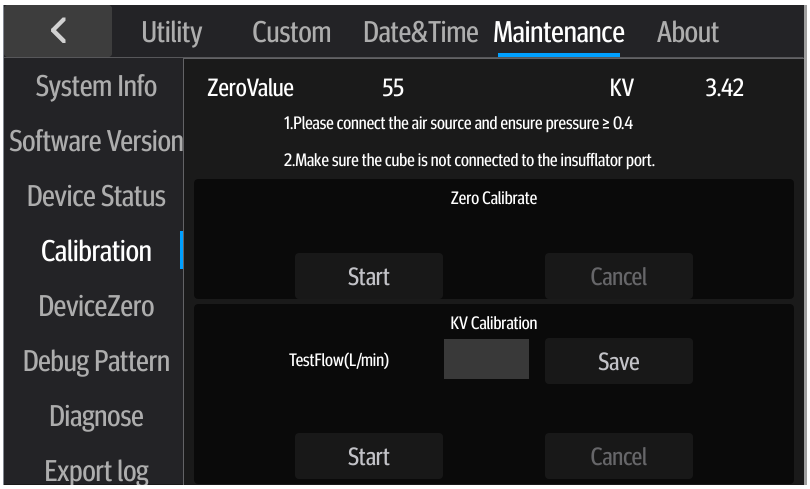


Figure 6-9 KV Calibration

6.5 Liquid Inlet State Clear

6.5.1 Contamination Removal for Insufflator V1.0

1. Confirm that parts contaminated by inlet liquid have been replaced (China: 115-063728-00, international: 115-063729-00, see 8.1 Spare Parts List).
2. See 10 for software upgrade.

6.5.2 Contamination Removal for Insufflator V2.0

1. Confirm that parts contaminated by inlet liquid have been replaced (115-076020-00, see 8.2 Spare Parts List).
2. Enter the diagnosis function interface (see 5.8.9), tap the **Clear** button, and change the liquid inlet status to **OK** to complete the contamination removal.

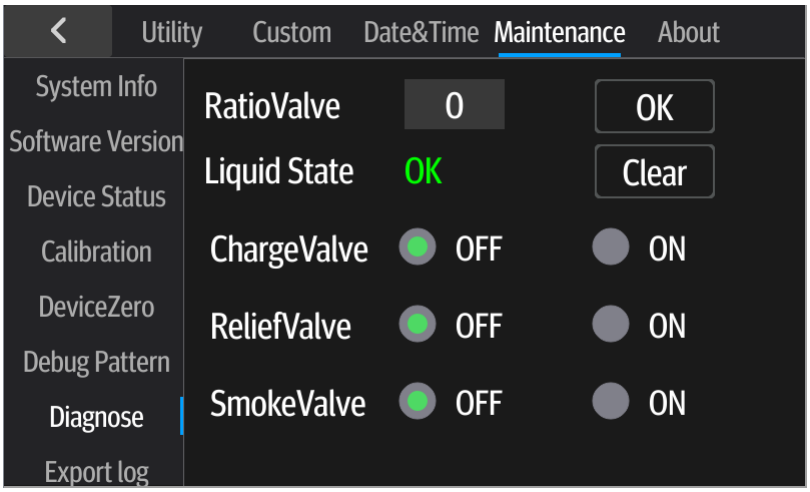


Figure 6-10 Contamination Removal

7 Test

7.1 Test/Calibration Report

After the test that is performed by the maintenance personnel approved by Mindray, record the test results according to the following test report and provide the report to Mindray Customer Service Department.

Test Device			
Name	**Model**		**Expiration Date**
No.	**Test/Calibration Item**	**Test/Calibration Point**	**Test/Calibration Result**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Result			
Qualified or not:		Tested by:	Date:

7.2 Appearance Inspection

1) The outside of the equipment is clean and without scratches. The equipment is firmly assembled. There is no sound of foreign objects inside the equipment when you shake the equipment.
2) Key respond quickly.
3) Markings are complete and content is correct.
4) Standard configuration is complete and sockets are assembled firmly.

7.3 Power-on Self-inspection

7.3.1 Tools

No

7.3.2 Test Procedure

1. Connect the gas source and power supply and ensure that the gas source pressure is not less than 0.4 MPa.
2. Start the machine. It will automatically perform power-on self-inspection.
3. The self-inspection is completed and the buzzer sounds once. The system enters the standby state (the insufflator V1.0 makes no buzzer sound after the self-inspection is completed). If there is no self-inspection error prompt, the self-inspection is passed.

7.4 Function Test

7.4.1 Ventilation Function Test

7.4.1.1 Tools

No

7.4.1.2 Test Procedure

1. Connect the gas source and power supply and ensure that the gas source pressure is not less than 0.4 MPa.
2. Start the insufflator and enter the standby state.
3. Connect the insufflator tube and start inflation.
4. If the insufflator works properly with no abnormal error prompt, the inflation function test is passed.

7.4.2 Stress Accuracy Test

7.4.2.1 Tools

Insufflator maintenance tools (898-002454-00), elastic airbag (3-5 L)

7.4.2.2 Test Procedure

1. Connect the gas source and power supply and ensure that the gas source pressure is not less than 0.4 MPa. Connect the gas injection port of the insufflator, air bag, and flowmeter (connect the differential pressure and interface) as shown below. As shown in the following figure:

Figure 7-1 Pressure Test Connection Diagram

NOTE

- **Set the flowmeter pressure unit to mmHg, and perform zero calibration before use.**
- **The air bag connector is in a vented state (the air bag connector wrench turns in the direction shown as the vented state).**

2. Start the insufflator and set the flow rate to 50 L/min (30 L/min for the 30 model).
3. Set the pressure to 5 mmHg and start inflation.
4. After the pressure is stable, read the pressure displayed by the insufflator and the pressure displayed by the flowmeter. If the difference between the pressure shown on the insufflator and the set pressure is smaller than 2 mmHg, and the difference between the pressure shown on the flowmeter and the pressure shown on the insufflator is smaller than 2 mmHg, the test is passed.
5. Set the pressure to 10 mmHg, 15 mmHg, 20 mmHg, and 30 mmHg respectively, and proceed to step 4 respectively. If all of them pass, the pressure test is passed.

7.4.3 Flow Accuracy Test

7.4.3.1 Tools

Insufflator maintenance tools (898-002454-00)

7.4.3.2 Test Procedure

1. Connect the gas source and power supply and ensure that the gas source pressure is not less

than 0.4 MPa. Connect the gas injection port of the insufflator, air bag, and flowmeter as shown below. Pay attention to the flow direction of the flowmeter gas.

Figure 7-2 Flow Test Connection Diagram

NOTE

- **Set the gas type of the flowmeter to the CO_2, and set the flow unit to ACT, L/min, and perform zero calibration before use.**

2. Start the insufflator and set the pressure to 15 mmHg.
3. Set the pressure to 5 L/min and start inflation.
4. After the flow is stable, read the flow displayed by the insufflator and the flow displayed by the flowmeter. If the difference between the flow shown on the insufflator and the set flow is smaller than 2 L/min or smaller than 20% of the set flow, and the difference between the pressure shown on the flowmeter and the pressure shown on the insufflator is significantly smaller than 2 L/min or smaller than 20% of the displayed flow, the test is passed.
5. Model 30: Set the flow to 15 L/min and 30 L/min respectively, and proceed to step 4 respectively. If all of them pass, the flow test is passed.
6. Model 50: Set the flow to 25 L/min and 50 L/min respectively, and proceed to step 4 respectively. If all of them pass, the pressure test is passed.

7.4.4 Heating Function Test

7.4.4.1 Tools

Heating insufflator tube (115-052867-00)

7.4.4.2 Test Procedure

1. Connect the gas source and power supply and ensure that the gas source pressure is not less than 0.4 MPa.
2. Start the insufflator and enter the standby state.
3. Connect the heating insufflator tube and start inflation.
4. After inserting the insufflator tube, the heating indicator will turn green. Touch the insufflator tube after 5 minutes, if it is slightly heated, the heating function test is passed.

7.4.5 Smoke Exhaust Function Test

7.4.5.1 Tools

Repetitive insufflator tube (115-052868-00), repetitive suction tube (115-052869-00), foot switch (115-049879-00), elastic airbag (3-5 L)

7.4.5.2 Test Procedure

1. Install the suction tube into the pinch valve. Connect the foot switch to the device socket.
2. Connect the gas injection port of the insufflator to the airbag through the gas tube.
3. Start the insufflator, set it to adult mode, set the inflation pressure and flow to the default settings (pressure 12 mmHg, flow 20 L/min) and start inflation.
4. When the displayed pressure reaches the set pressure, step on the foot switch.
5. Visually check whether the foot switch pinch valve contracts when the switch is stepped on. If yes, the smoke exhaust function test is passed.

7.4.6 Gas source detection function test

7.4.6.1 Tools

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7.4.6.2 Test Procedure

1. Connect the gas source and ensure that the gas source pressure is not less than 0.4 MPa.
2. Start the insufflator. Tap **Setting** in standby to enter the setting interface. Select the **General Setting** page, and set the gas source type to **Cylinder Supply**.
3. Exit the setting interface, the insufflator should have a reminder of insufficient gas source.
4. Tap **Setting** to enter the setting interface, select the **General Setting** page. Set the gas source type to Central Gas Supply, and then exit the setting interface.
5. Start the device, inflate and then start inflation (the default is adult mode). The insufflator should display normal gas source pressure with no abnormal gas source prompts.
6. Disconnect the gas source in the inflated state. The insufflator should show insufficient gas source for about 1 minute.

7.4.7 Touchscreen Function Test

7.4.7.1 Tools

/

7.4.7.2 Test Procedure

1. Start the equipment, which enters standby mode after self-inspection.
2. Change the inflation mode, change the set pressure, set the flow rate, tap **Start**, then tap **Close**, tap the **Setting** button to enter the setting menu. Tap **General Setting**, **Custom**, **Date and Time**, **Manufacturer Maintenance, About**. If the touchscreen is sensitive and accurate, the test is passed.

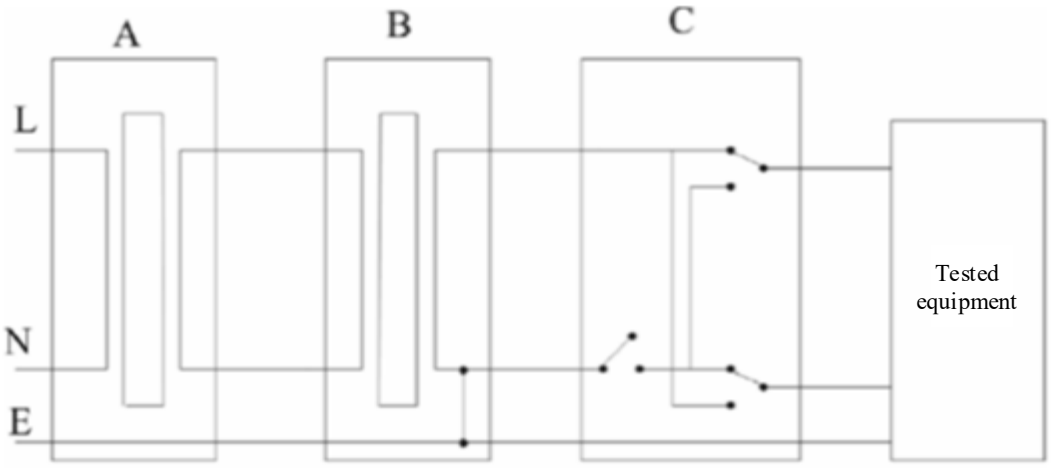
7.5 Electrical safety test

7.5.1 Precautions

⚠WARNING

- **Electrical safety tests are used to detect abnormalities that, if undetected in time, could cause injuries to either the patients or the operators.**
- **All tests can be performed using commercially available safety analyzer and other test devices. Maintenance personnel shall ensure the adaptability, functional completeness and safety of the test devices, and be familiar with their usage.**
- **Electrical safety tests shall comply with the following standards: GB9706.1 and EN 60601-1.**
- **In case of other stipulations in local laws and regulations, implement electrical safety tests by following relevant stipulations.**
- **All devices driven by AC power and connected to medical instruments in patient zones must comply with the IEC 60601-1/GB9706.1 standard. And electrical safety tests on these devices must be implemented in accordance with the test interval of the insufflator.**

Electrical safety tests are used to timely detect potential electrical safety risks that might cause injuries to patients, operators or maintenance personnel. Electrical safety tests must be carried out under normal environmental conditions (that is, normal temperature, humidity and barometric pressure).
The electrical safety tests described in this chapter take 601 safety analyzer as an example. The safety analyzer used in different regions may vary. Make sure that the electrical safety test scheme you adopted is applicable.
Device connection is shown in the following figure.



A: AC power supply (programmable power supply, adjustable frequency) B: Isolation transformer on the leakage current test tool C: Safety tester

Figure 7-3 Device Connection Diagram

7.5.2 Test Tools

Safety analyzer (recommended model: 601Pro, equivalent or device of higher specifications can also be used)

Accessory: heating insufflator tube (115-052867-00)

7.5.3 Test Procedure

7.5.3.1 Enclosure Leakage Current Test

1) Connect the 601 safety analyzer to a 264 V AC 60 Hz power supply.
2) Connect the applied part to the RA end of the safety analyzer.
3) Use the power cable to connect the EUT to the auxiliary power output connector of the 601 safety analyzer.
4) Connect one end of the red lead to the "Red input terminal" of the safety analyzer, and clip the other end on the metal foil attached on the surface of the outer enclosure of the EUT.
5) Power on the 601 safety analyzer. Press **5-Enclosure leakage** on the panel to access the screen for enclosure leakage current test.
6) The enclosure leakage current is not greater than 100 μA in normal condition and is not greater than 500 μA in single fault condition.

7.5.3.2 Earth Leakage Current Test

1) Connect the 601 safety analyzer to a 264 V AC 60 Hz power supply.
2) Connect the application part of the EUT to the RA terminal of the safety analyzer.
3) Use the power cable to connect the EUT to the auxiliary power output connector of the 601 safety analyzer.
4) Power on the 601 safety analyzer. Press **4-Earth leakage** on the panel to access the screen for earth leakage current test.
5) The enclosure leakage current is not greater than 500 μA in normal condition and is not greater than 1000 μA in single fault condition.

7.5.3.3 Patient Leakage Current Test

1) Connect the 601 safety analyzer to a 264 V AC 60 Hz power supply.
2) Connect the applied part to the RA end of the safety analyzer.
3) Use the power cable to connect the EUT to the auxiliary power output connector of the 601 safety analyzer.
4) Power on the 601 safety analyzer. Press **6-Patient leakage** on the panel.
5) Press the **APPLIED PART** key repeatedly to select AC and DC measurement. When DC is selected, the "DC" text is displayed next to the limit.
6) The patient leakage current is not greater than 100 μA in normal condition and is not greater than 500 μA in single fault condition.
7) If electrical safety tests fail, please contact technical support personnel of Mindray.

8 Spare Parts List

This chapter offers the spare parts list of the insufflator system to help service personnel identify the parts during disassembly and replacement.

8.1 Spare Parts List for Insufflator V1.0

The spare parts list of the insufflator (V1.0) is shown in the following table, and the corresponding exploded diagram is shown in Figure 8-1:

No.	Parts Code	Description	Qty	Removal reference section	Calibration and testing required after replacement
1	115-063705-00	Filter service parts	1	9.4	Tests: 7.2, 7.3, 7.4.1 and 7.5
2	115-063707-00	Insufflator power module material package	1	9.8	Tests: 7.2, 7.3, 7.4.1, 7.4.4, 7.4.6 and 7.5
3	115-078502-00	Main board service material package	1	9.10	Upgrade: See 10 Calibration: 6.1, 6.2 and 6.4 Settings: general settings (5.7.1), model and series settings (5.7.2.3), time settings (0) Tests: 7.2, 7.3, 7.4.2, 7.4.3, 7.4.4, 7.4.5 and 7.4.6
4	115-077921-00	Pneumatic module service spare parts (general version)	1	9.6	Calibration: 6.4 Tests: 7.2, 7.3, 7.4.2, 7.4.3, 7.4.4 and 7.4.6
5	115-076021-00	Heating plate service parts	1	9.15	Tests: 7.2, 7.3, 7.4.1 and 7.4.4
6	115-063713-00	Power keypad (FRU)	1	9.14	Tests: 7.2, 7.3 and 7.4.1
7	115-063715-00	LCD display repair spare parts	1	9.13	Tests: 7.2, 7.3 and 7.4.1
8	115-063716-00	Touchscreen repair spare parts	1	9.13	Calibration: 6.1 Tests: 7.2, 7.3, 7.4.1 and 7.4.7
9	115-063717-00	USB board repair spare parts	1	9.16	Test: 7.2, 7.3 and 7.4.1. Export logs (5.7.3.5)
10	115-063718-00	SCI board repair spare parts	1	9.17	Test: 7.2, 7.3 and 7.4.1.
11	115-063719-00	Network connector board repair spare parts	1	9.18	Test: 7.2, 7.3 and 7.4.1.

12	115-063720-00	Gas inlet repair spare parts	1	9.2	Tests: 7.2, 7.3, 7.4.1 and 7.4.6
13	115-063721-00	Filter repair spare parts	1	9.2	Tests: 7.2, 7.3, 7.4.1 and 7.4.6
14	115-063722-00	High-pressure valve assembly repair spare parts	1	9.3	Calibration: 6.2 Tests: 7.2, 7.3, 7.4.1 and 7.4.6
15	115-063723-00	Low-pressure valve assembly repair spare parts	1	9.5	Tests: 7.2, 7.3 and 7.4.1
16	115-074340-00	Pressure relief valve assembly repair spare parts	1	9.7	Tests: 7.2, 7.3, 7.4.2, 7.4.3 and 7.4.4
17	115-063725-00	Sensor connecting pipe repair spare parts	1	9.20	Tests: 7.2, 7.3, 7.4.2 and 7.4.3
18	115-063727-00	Pinch valve repair spare parts	1	9.19	Tests: 7.2, 7.3, 7.4.1 and 7.4.5
19	115-063728-00	Liquid inlet sensor repair spare parts (China)	1	9.11、9.10、9.6	Upgrade: See 10 Calibration: 6.1, 6.2 and 6.4 Settings: general settings (5.7.1), model and series settings (5.7.2.3), time settings (0) Tests: 7.2, 7.3, 7.4.2, 7.4.3, 7.4.4, 7.4.5 and 7.4.6
20	115-063729-00	Liquid inlet sensor repair spare parts (foreign)	1	9.11、9.10、9.6	Upgrade: See 10 Calibration: 6.1, 6.2 and 6.4 Settings: general settings (5.7.1), model and series settings (5.7.2.3), time settings (0) Tests: 7.2, 7.3, 7.4.2, 7.4.3, 7.4.4, 7.4.5 and 7.4.6
21	115-078501-00	Rubber hose. Precision soft PU hose 7 mm × 10 mm repair spare parts	1	9.22	Tests: 7.2, 7.3 and 7.4.1

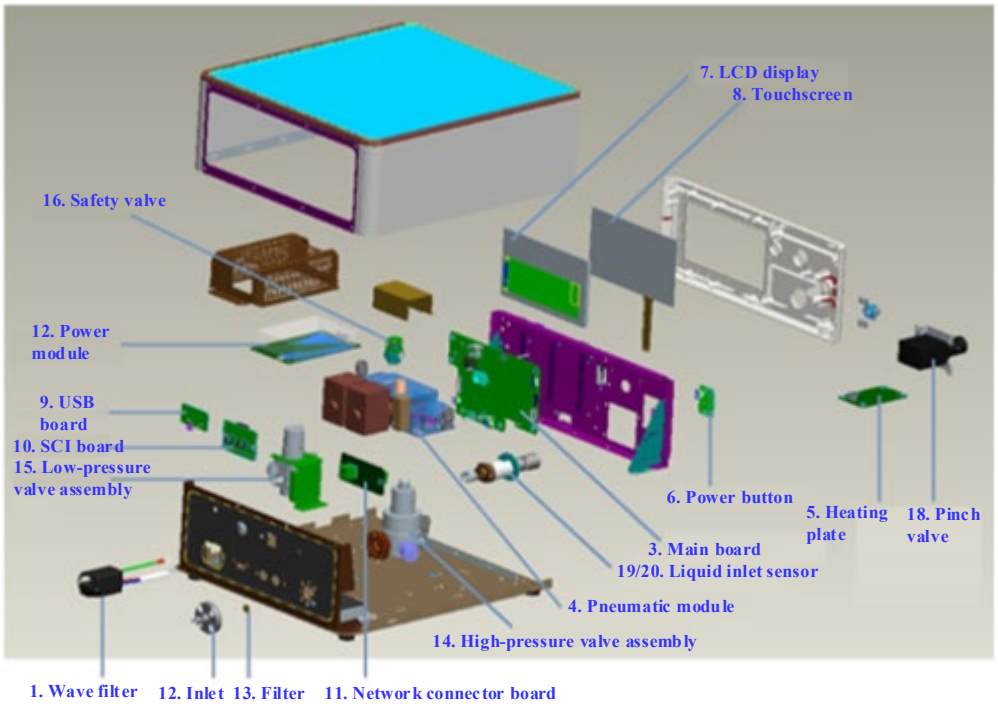


Figure 8-1 Spare Parts List

8.2 Spare Parts List for Insufflator V2.0

The spare parts list of the insufflator (V2.0 or above) is shown in the following table, and the corresponding exploded diagram is shown in Figure 8-1:

No.	Parts Code	Description	Qty	Removal reference section	Calibration and testing required after replacement
1	115-063705-00	Filter service parts	1	9.4	Tests: 7.2, 7.3, 7.4.1 and 7.5
2	115-063707-00	Insufflator power module material package	1	9.8	Tests: 7.2, 7.3, 7.4.1, 7.4.4, 7.4.6 and 7.5
3	115-077924-00	Insufflator motherboard repair spare parts (general version)	1	9.10	Upgrade: 10 Settings: general settings (5.8.1), time settings (5.8.2), model and series settings (5.8.4) Calibration: 6.2, 6.3 and 6.4 Tests: 7.2, 7.3, 7.4.2, 7.4.3, 7.4.4, 7.4.5, 7.4.6 and 7.4.7
4	115-077921-00	Pneumatic module service spare parts (general version)	1	9.6	Calibration: 6.4 Tests: 7.2, 7.3, 7.4.2, 7.4.3,

					7.4.4 and 7.4.6
5	115-076021-00	Heating plate service parts	1	9.15	Tests: 7.2, 7.3, 7.4.1 and 7.4.4
6	115-063713-00	Power keypad (FRU)	1	9.14	Tests: 7.2, 7.3 and 7.4.1
7	115-063715-00	LCD display repair spare parts	1	9.13	Tests: 7.2, 7.3 and 7.4.1
8	115-074976-00	Touchscreen repair spare parts (capacitive screen)	1	9.13	Tests: 7.2, 7.3, 7.4.1 and 7.4.7
9	115-063717-00	USB board repair spare parts	1	9.16	Test: 7.2, 7.3 and 7.4.1. Export logs, see 5.7.3.5
10	115-063718-00	SCI board repair spare parts	1	9.17	Test: 7.2, 7.3 and 7.4.1.
11	115-063719-00	Network connector board repair spare parts	1	9.18	Test: 7.2, 7.3 and 7.4.1.
12	115-063720-00	Gas inlet repair spare parts	1	9.2	Tests: 7.2, 7.3, 7.4.1 and 7.4.6
13	115-063721-00	Filter repair spare parts	1	9.2	Tests: 7.2, 7.3, 7.4.1 and 7.4.6
14	115-074339-00	High-pressure valve assembly repair spare parts (general version)	1	9.3	Calibration: 6.2 Tests: 7.2, 7.3, 7.4.1 and 7.4.6
15	115-063723-00	Low-pressure valve assembly repair spare parts	1	9.5	Tests: 7.2, 7.3 and 7.4.1
16	115-074340-00	Pressure relief valve assembly repair spare parts	1	9.7	Tests: 7.2, 7.3, 7.4.2, 7.4.3 and 7.4.4
17	115-063725-00	Sensor connecting pipe repair spare parts	1	9.20	Tests: 7.2, 7.3, 7.4.2 and 7.4.3
18	115-063727-00	Pinch valve repair spare parts	1	9.19	Tests: 7.2, 7.3, 7.4.1 and 7.4.5
19	115-076020-00	Liquid inlet contamination repair spare parts	1	9.11	Calibration: 6.5 Tests: 7.2, 7.3 and 7.4.1
20	115-078501-00	Rubber hose. Precision soft PU hose 7 mm × 10 mm repair spare parts	1	9.22	Tests: 7.2, 7.3 and 7.4.1

9 Disassembly and Maintenance

9.1 Disassembling the Upper Cover Assembly

9.1.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.1.2 Preparations for Disassembly

Before disassembling this part, please make the following preparations:

- Stop using the insufflator and turn off the standby switch of the insufflator.
- Ensure that the AC power and all the output connectors on the front and rear panels are completely disconnected.
- Make sure that the gas supply has been disconnected.

9.1.3 Disassembly

1. 1. Remove the eight M3 combination screws on the rear panel.
2. 2. Pull the upper cover back in the direction indicated by the arrow until the entire upper cover assembly is released. Pull the upper cover assembly upwards in the direction indicated by the arrow to disassemble the upper cover assembly.

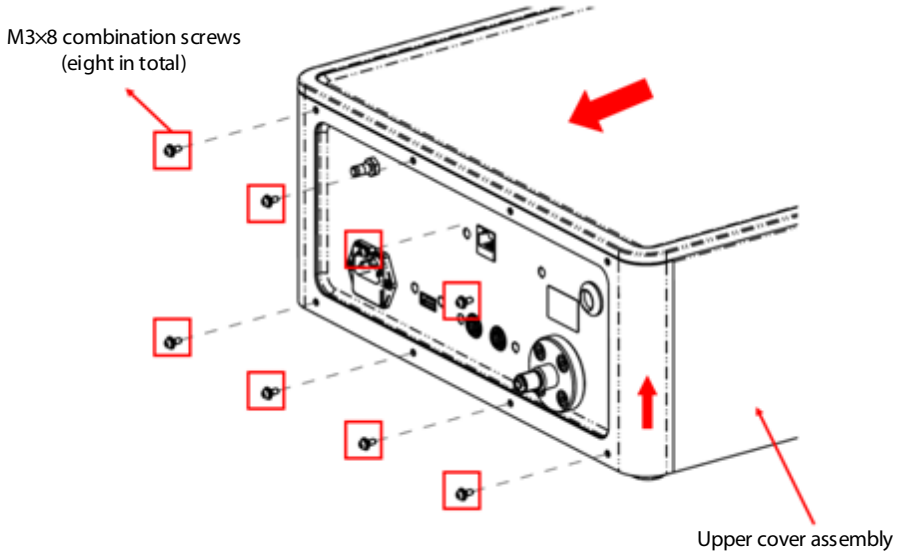


Figure 9-1 Disassembling the Upper Cover Assembly

9.2 Disassembling Gas Inlet and Filter

9.2.1 Tools

During part disassembly and replacement, the following tools may be used:

- Hexagon wrench

9.2.2 Preparations for Disassembly

/

9.2.3 Pre-disassembly

/

9.2.4 Disassembly

Remove the four M4 hexagon socket screws of the gas inlet and take out four spring washers and flat washers to remove the high-pressure gas inlet, filter, high-pressure sealing gasket, and sealing ring.

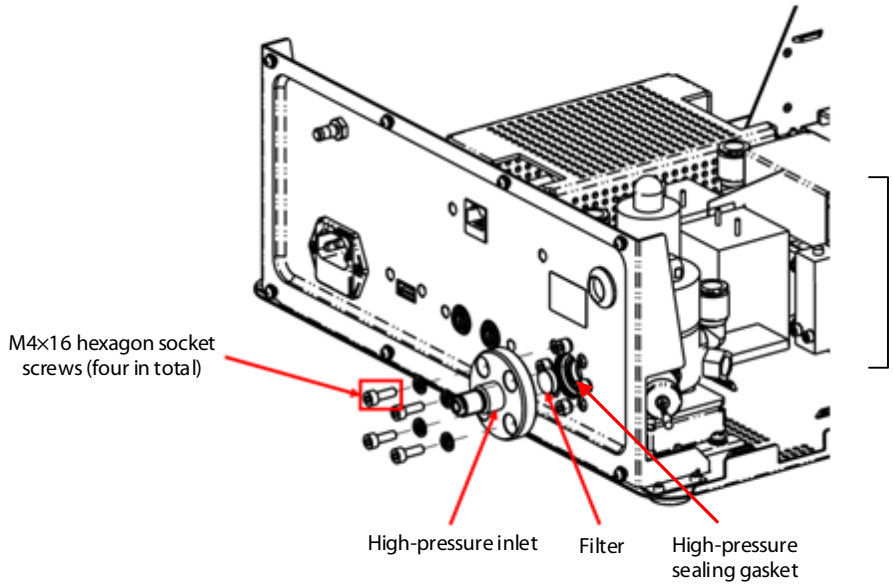


Figure 9-2 Disassembling Gas Inlet and Filter

9.3 Disassembling the High-pressure Valve Assembly

9.3.1 Tools

During part disassembly and replacement, the following tools may be used:

- Hexagon wrench

- Phillips screwdrivers

9.3.2 Preparations for Disassembly

/

9.3.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

Remove the high-pressure gas inlet connector and filter. See 9.2.

9.3.4 Disassembly

Remove all cables and pipes connected to the high-pressure valve, and then use a Hexagon wrench to remove the four M4×16 combination screws that fix the connecting flange to remove the high-pressure valve assembly.

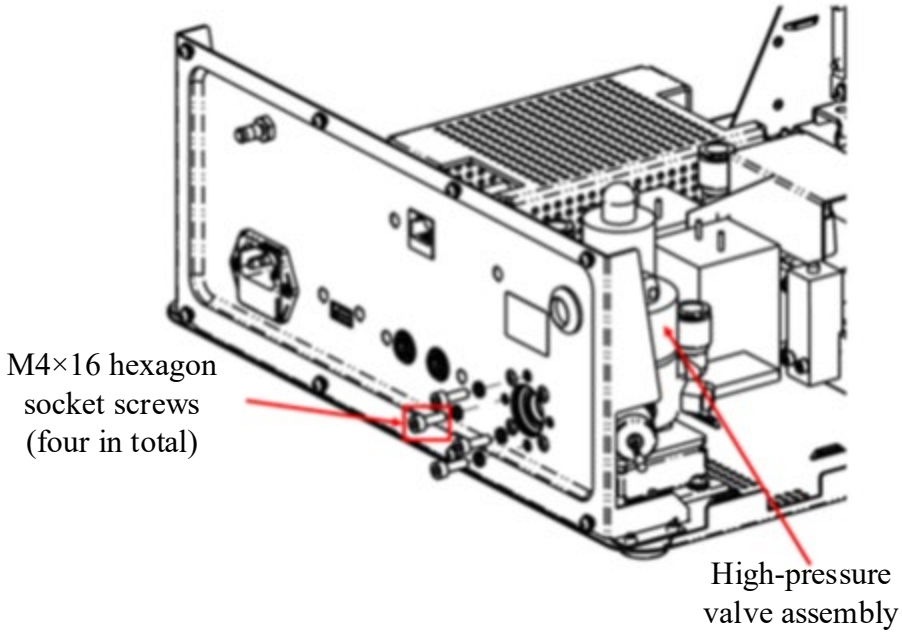


Figure 9-3 Disassembling the High-pressure Valve Assembly

9.4 Disassembling the Filter Assembly

9.4.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.4.2 Preparations for Disassembly

/

9.4.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.4.4 Disassembly

Remove the ground terminal of the filter tail wire harness. Unplug the other wire harnesses at the filter tail. Use a Phillips screwdriver to remove the two M3×6 cross-recessed countersunk screws that lock the filter to remove the filter assembly.

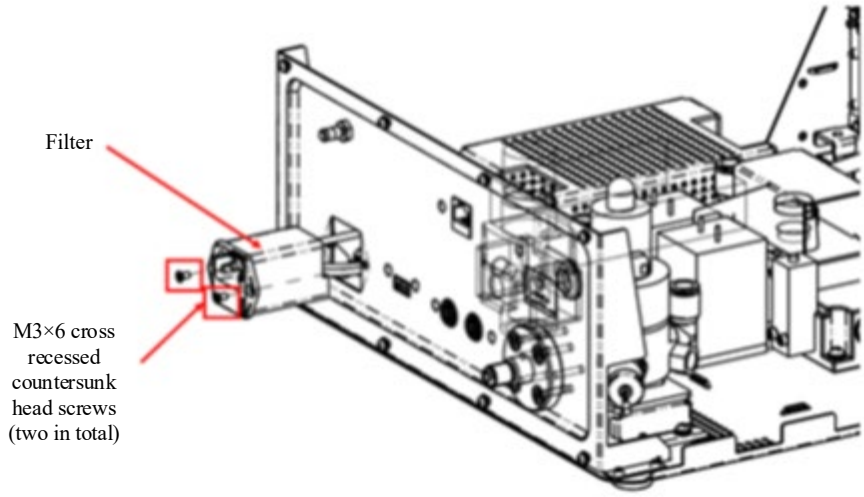


Figure 9-4 Disassembling the Filter Assembly

9.5 Disassembling the Low-pressure Valve Assembly

9.5.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.5.2 Preparations for Disassembly

/

9.5.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.5.4 Disassembly

Remove the pipe connected to the low-pressure pressure reducer assembly. Use a Phillips screwdriver to remove the two M4×8 combination screws that lock the pressure reducer to remove the low-pressure reducer assembly.

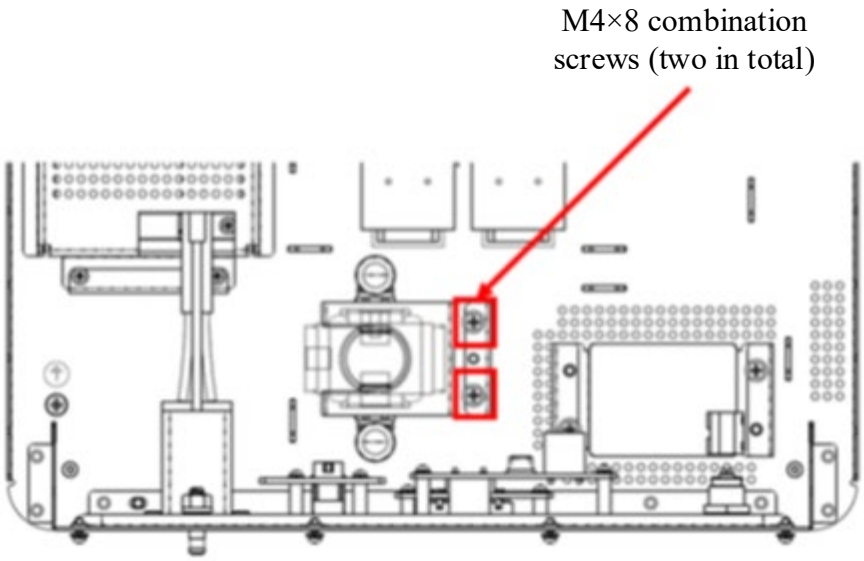


Figure 9-5 Disassembling the Low-pressure Valve Assembly

9.6 Disassembling the Pneumatic Module

9.6.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.6.2 Preparations for Disassembly

/

9.6.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.6.4 Disassembly

Remove all the cables and tubes connected to the pneumatic module. Use a Phillips screwdriver to remove the four M4×12 combination screws that fix the pneumatic module. Then, the pneumatic module can be removed.

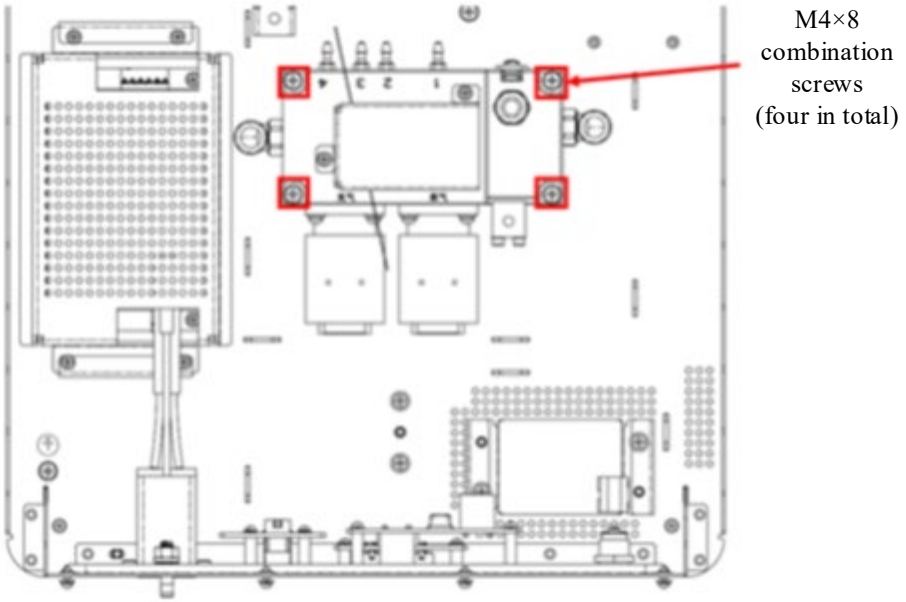


Figure 9-6 Disassembling the Pressure Relief Valve Assembly

9.7 Disassembling the Pressure Relief Valve

9.7.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.7.2 Preparations for Disassembly

/

9.7.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.7.4 Disassembly

Use a Phillips screwdriver to remove the two M3×8 combination screws that fix the safety valve baffle. Remove the safety valve baffle. Then, unscrew the pressure relief valve by hand.

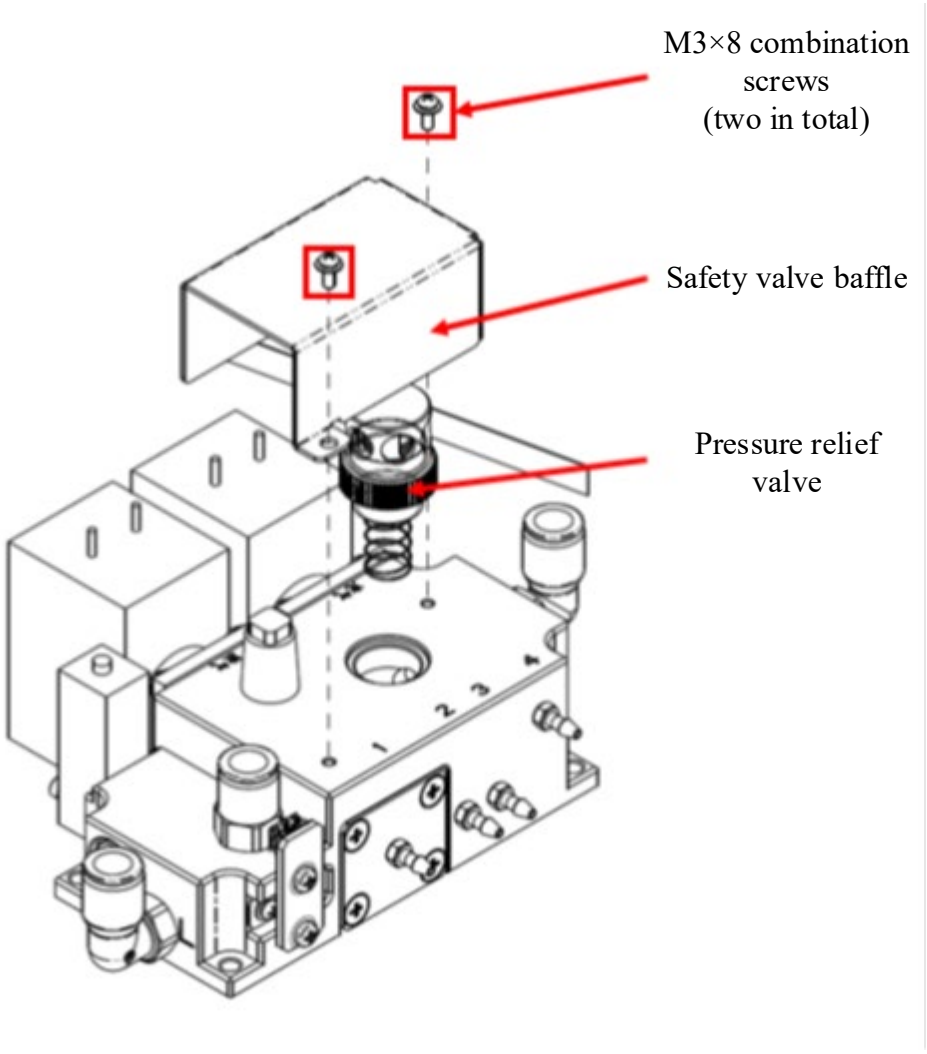


Figure 9-7 Disassembling the Pressure Relief Valve

9.8 Disassembling the Power Module

9.8.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.8.2 Preparations for Disassembly

/

9.8.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.8.4 Disassembly

First remove all the cables connected to the AC-DC. Use a Phillips screwdriver to remove the four M3×8 combination screws that fix the power shield box. Remove the power shield box. Use the screwdriver to remove the four M3×8 screws that fix the AC-DC module. The AC-DC module can be removed.

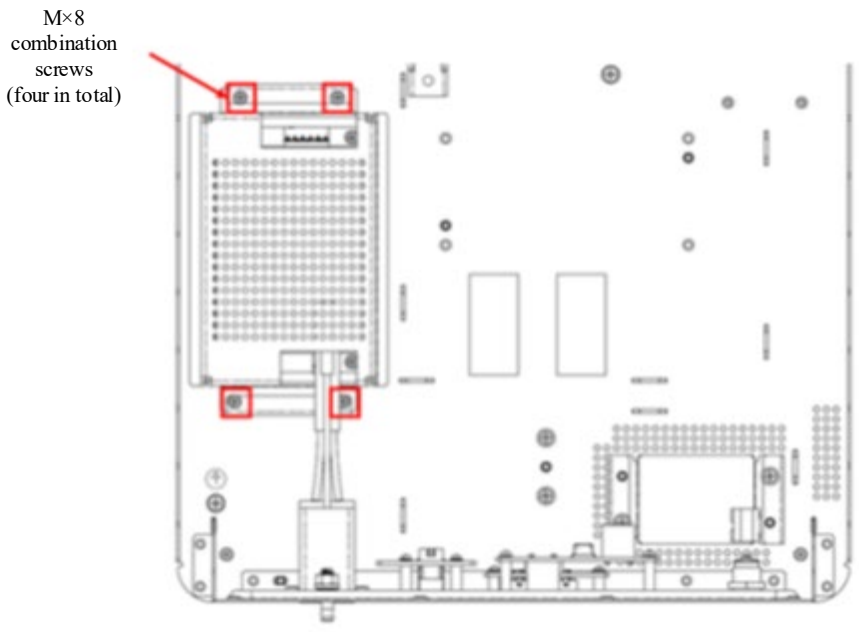


Figure 9-8 Disassembling the AC-DC Module

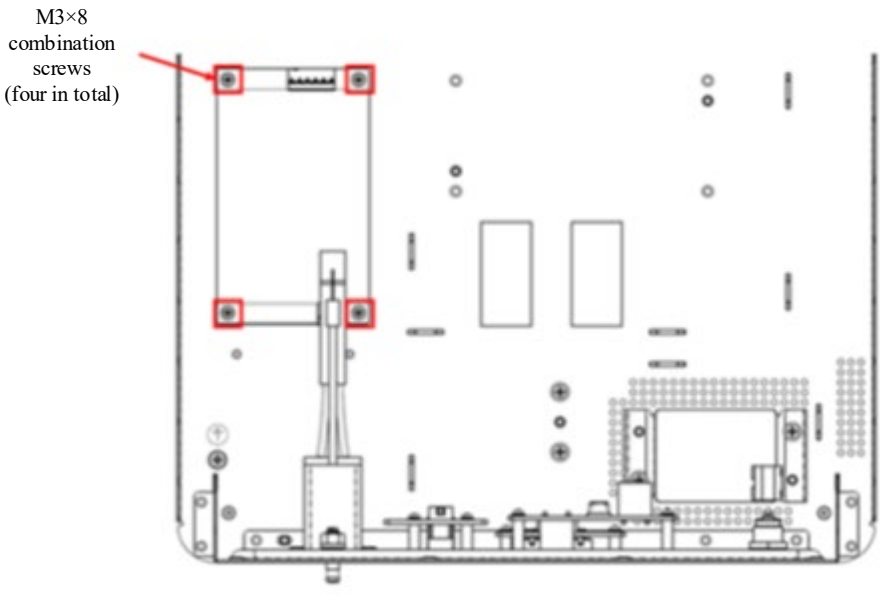


Figure 9-9 Disassembling the AC-DC Module

9.9 Disassembling the Front Panel Assembly

9.9.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.9.2 Preparations for Disassembly

/

9.9.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.9.4 Disassembly

First remove all the cables and pipes connected to the front panel assembly. Use a Phillips screwdriver to remove the nine M3×8 screws fixing the front panel assembly to remove the front panel assembly.

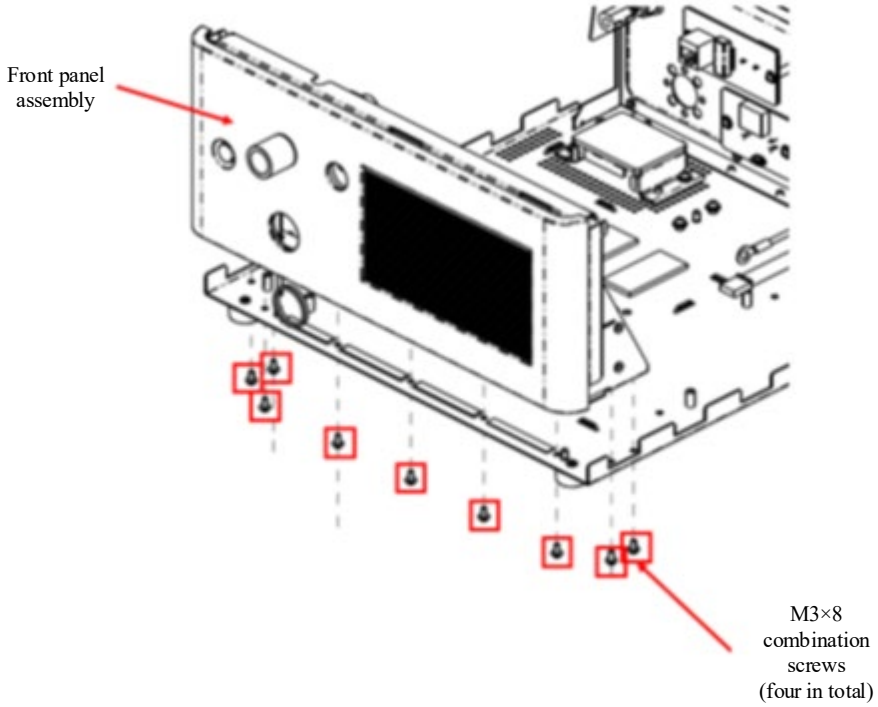


Figure 9-10 Disassembling the Front Panel

9.10 Disassembling the CCU

9.10.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.10.2 Preparations for Disassembly

/

9.10.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

Remove the front panel assembly. See 9.9.

9.10.4 Disassembly

First remove all the cables connected to the main board. Use a Phillips screwdriver to remove the seven M3×8 combination screws that fix the main board and the two M3×20 screws that fix the sensor to remove the main board.

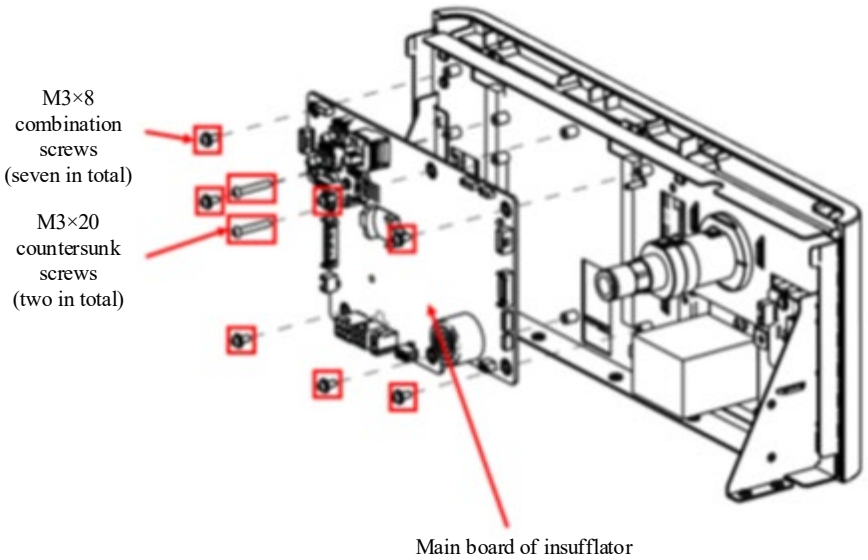


Figure 9-11 Disassembling the Main Board

9.11 Disassembling the Liquid Sensor and Outlet Connector

9.11.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.11.2 Preparations for Disassembly

/

9.11.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.11.4 Disassembly

1. First use a Phillips screwdriver to remove one M3×8 combination screw of the liquid sensor cable, and then remove the liquid sensor cable.
2. Use a Phillips screwdriver to remove one M3×8 combination screw as shown in the figure, and then pull it out in the direction of the arrow by hand to remove the liquid sensor.
3. Tighten the clamp (041-039253-00, in the repair spare parts package) with the insufflator tube connector to unscrew the gas outlet fixing flange. Push the gas outlet out from the inside of the machine.

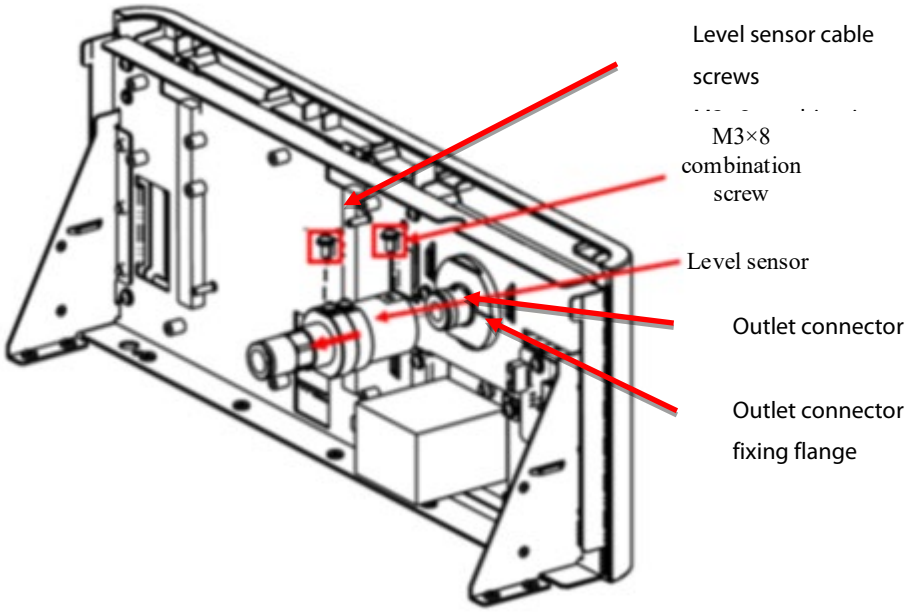


Figure 9-12 Disassembling the Liquid Sensor and Outlet Connector

9.12 Disassembling the Front Shell and Display

9.12.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.12.2 Preparations for Disassembly

/

9.12.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

Remove the front panel assembly. See 9.9.

Disassemble the liquid sensor (without disassembling the outlet connector). See 9.11.

9.12.4 Disassembly

Use a Phillips screwdriver to remove the six M3×8 combination screws as shown in the figure. Use the insufflator tube connector to tighten the clamp (041-039253-00, in the repair spare parts package). Remove the lock nut, and remove the front shell and display.

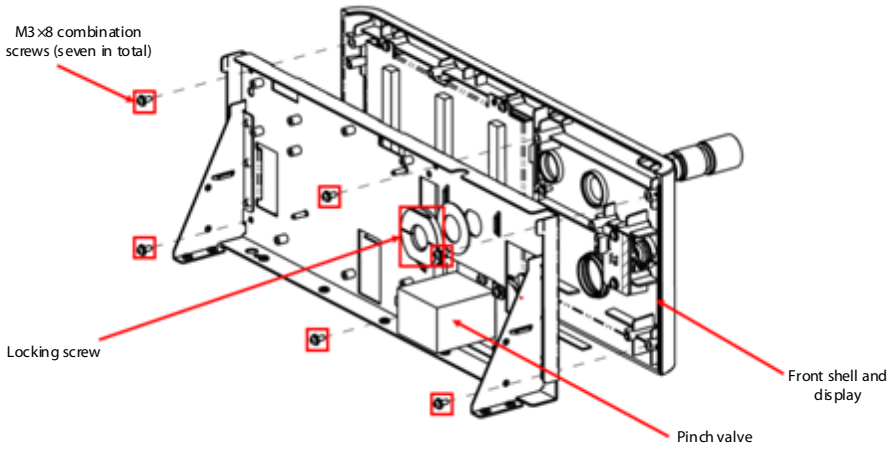


Figure 9-13 Disassembling the Front Shell and Display

9.13 Disassembling the Display and Touchscreen

9.13.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.13.2 Preparations for Disassembly

/

9.13.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

Remove the front panel assembly. See 9.9.

Disassemble the liquid sensor (without disassembling the outlet connector). See 9.11.

Disassemble the front shell and display, see 9.12.

9.13.4 Disassembly

First use a Phillips screwdriver to remove the four M3×8 combination screws as shown in the figure, then the display bracket, display and touchscreen can be removed.

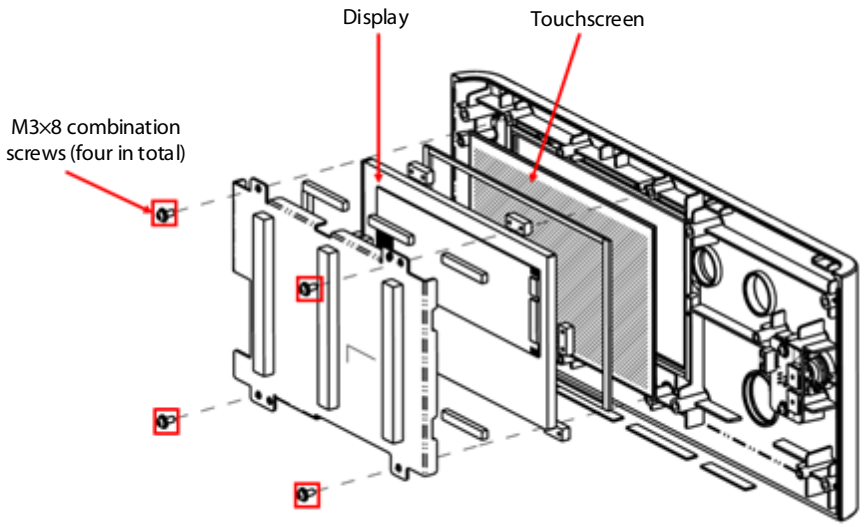


Figure 9-14 Disassembling the Display and Touchscreen

9.14 Disassembling the Power Keypad

9.14.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.14.2 Preparations for Disassembly

/

9.14.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.14.4 Disassembly

Use a Phillips screwdriver to remove the two M3×8 combination screws as shown in the figure to remove the power button.

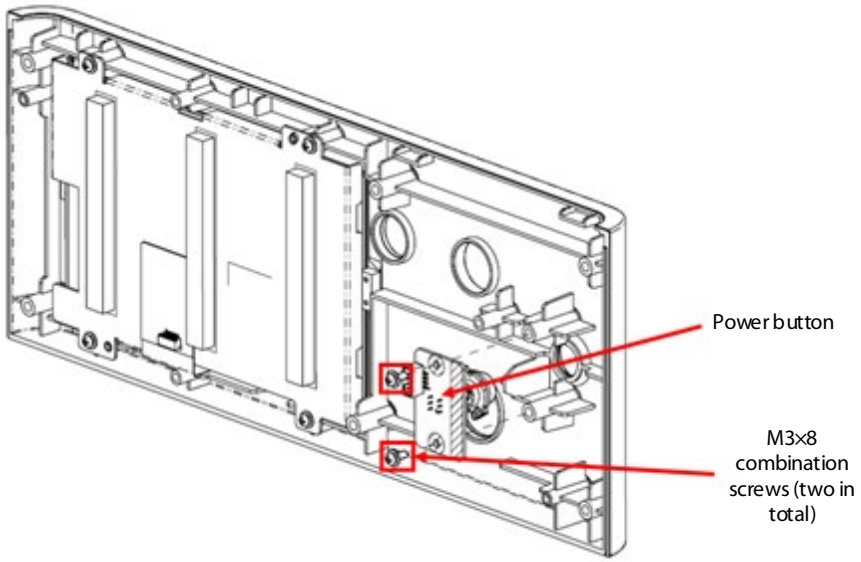


Figure 9-15 Disassembling the Display and Touchscreen

9.15 Disassembling the Heating Plate

9.15.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.15.2 Preparations for Disassembly

/

9.15.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.15.4 Disassembly

1. Use a Phillips screwdriver to remove the four M3×8 combination screws as shown in the figure to remove the heating plate.

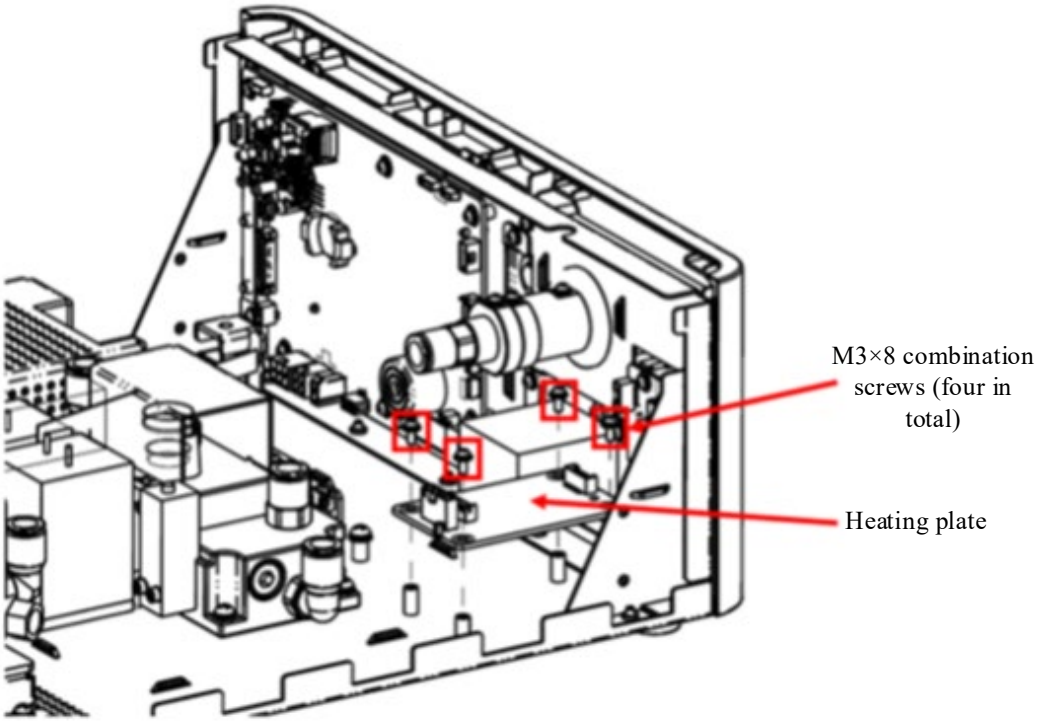


Figure 9-16 Disassembling the Heating Plate

9.16 Disassembling the USB Board

9.16.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.16.2 Preparations for Disassembly

/

9.16.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

Remove the low-pressure valve Assembly. See 9.5.

9.16.4 Disassembly

Use a Phillips screwdriver to remove the two M3×8 combination screws on the rear panel, then the USB board, network connector board, and CAN port board can be removed.

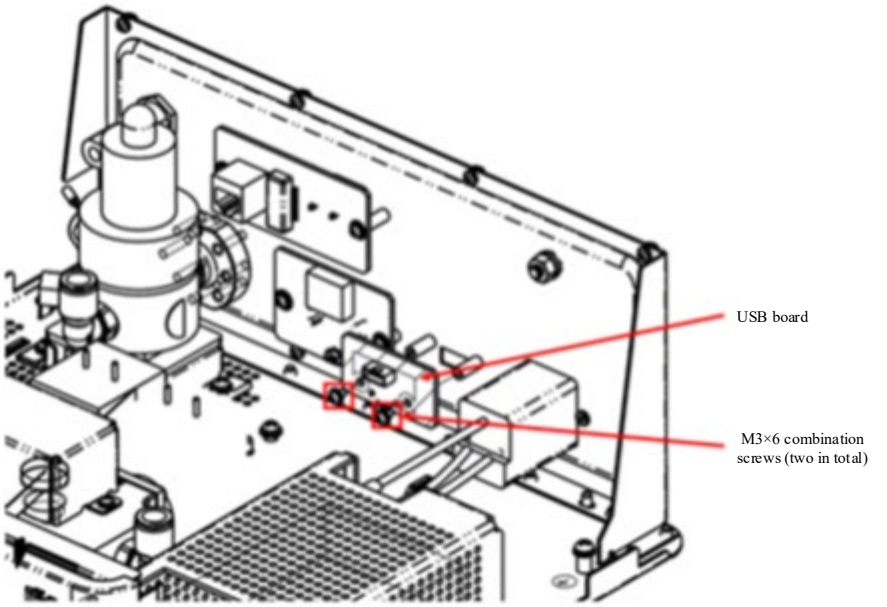


Figure 9-17 Disassembling the USB Board

9.17 Disassembling the CAN Board

9.17.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.17.2 Preparations for Disassembly

/

9.17.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.
Remove the low-pressure valve Assembly. See 9.5.

9.17.4 Disassembly

Use a Phillips screwdriver to remove the two M3×6 combination screws on the rear panel, then the CAN board can be removed.

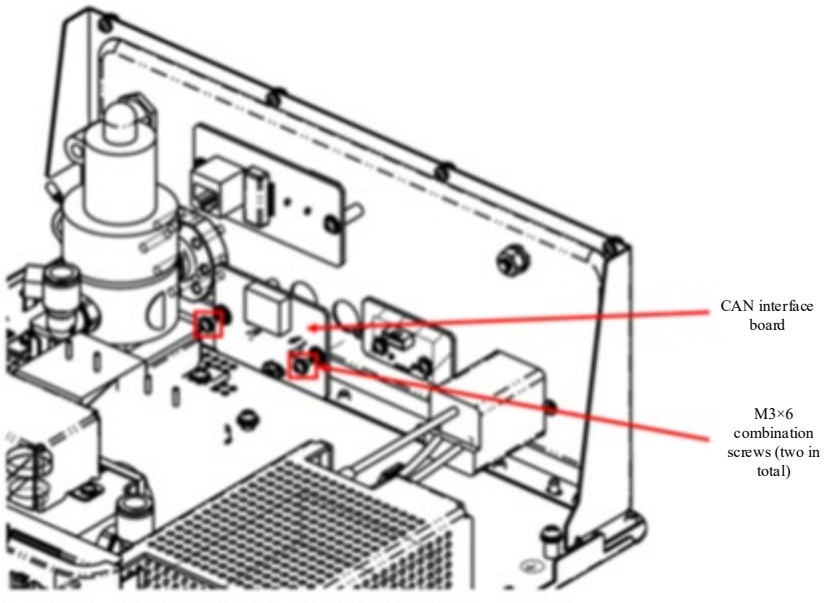


Figure 9-18 Disassembling the CAN Board

9.18 Disassembling the Network Connector Board

9.18.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.18.2 Preparations for Disassembly

/

9.18.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

Remove the low-pressure valve Assembly. See 9.5.

9.18.4 Disassembly

Use a Phillips screwdriver to remove the two M3×6 combination screw on the rear panel to remove the network connector board.

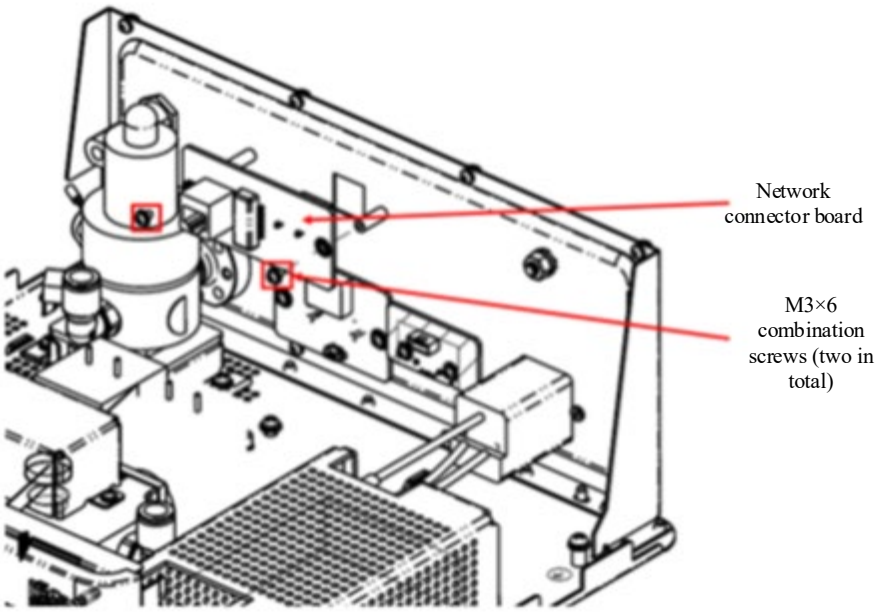


Figure 9-19 Disassembling the Network Connector Board

9.19 Disassembling the Pinch Valve

9.19.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.19.2 Preparations for Disassembly

/

9.19.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

Remove the front panel assembly. See 9.9.

9.19.4 Disassembly

Use a screwdriver to remove the four M3×8 combination screws that fix the pinch valve assembly. Remove the pinch valve assembly. Use a screwdriver to remove the two M3×8 combination screws that fix the pinch valve. Then, the pinch valve can be replaced.

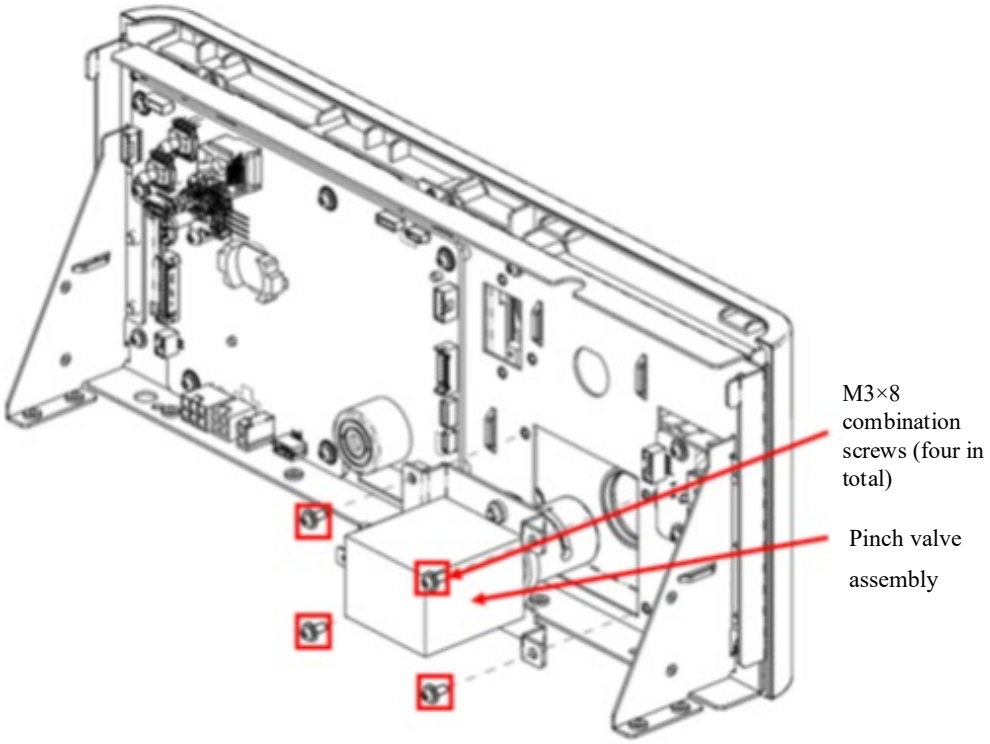


Figure 9-20 Replacing the Pinch Valve

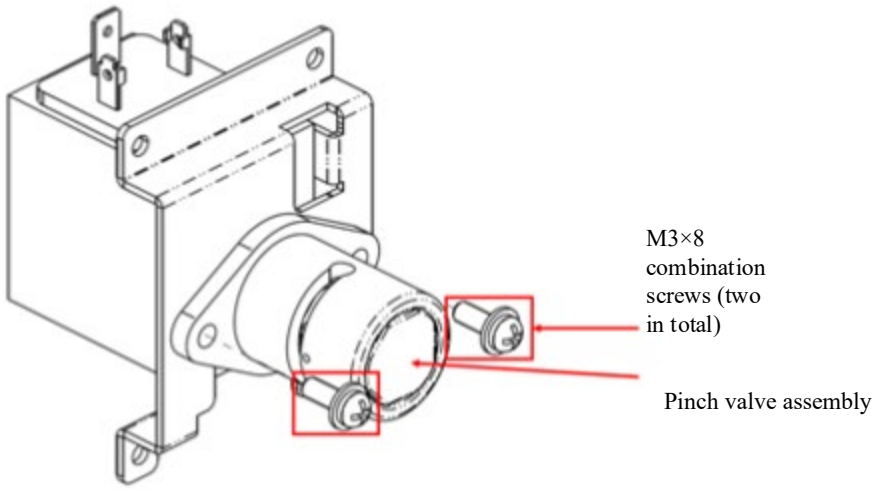


Figure -21 Disassembling the Pinch Valve

9.20 Disassembling the Sensor Connection Tubes and Button Battery

9.20.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.20.2 Preparations for Disassembly

/

9.20.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.20.4 Disassembly

After unplugging the four sensor connection tubes (including filters), the sensor connection tubes (including filters) can be replaced, see Figure 9-22.

As shown in Figure 9-22, the button battery on the main board can be directly removed and replaced.

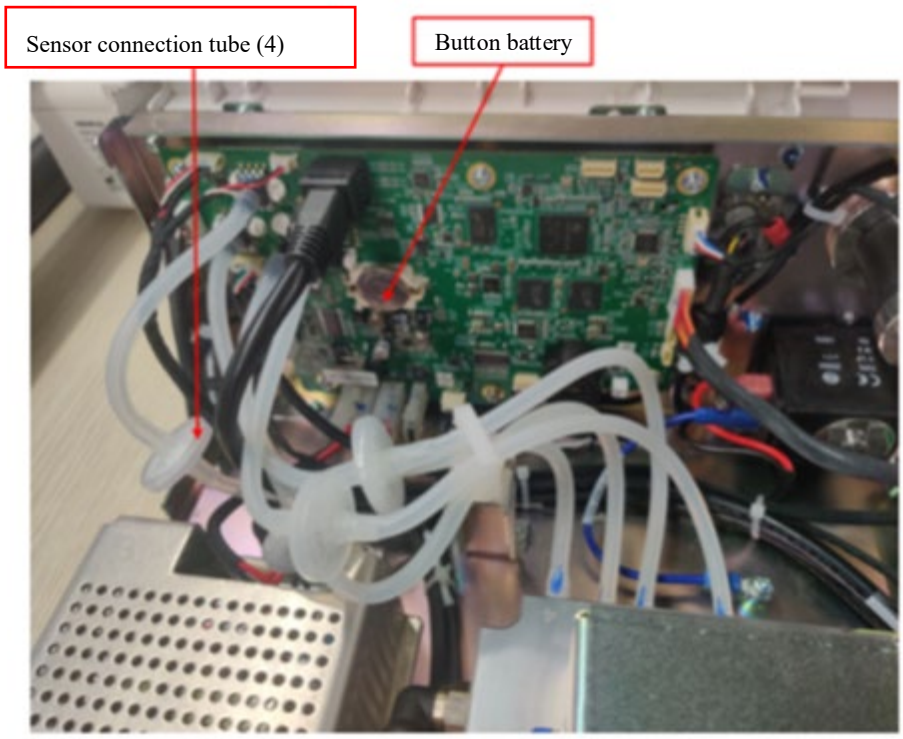


Figure 9-22 Disassembling the Sensor Connection Tubes

9.21 Disassembling the Anti-Contamination Filter

9.21.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.21.2 Preparations for Disassembly

/

9.21.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.21.4 Disassembly

After disassembling the pagoda connectors on both sides of the anti-contamination filter assembly from the quick-in connector (press the end of the quick-in connector inward to pull the pagoda connectors out of the quick-in connector), you can replace the anti-contamination filter assembly as shown in.

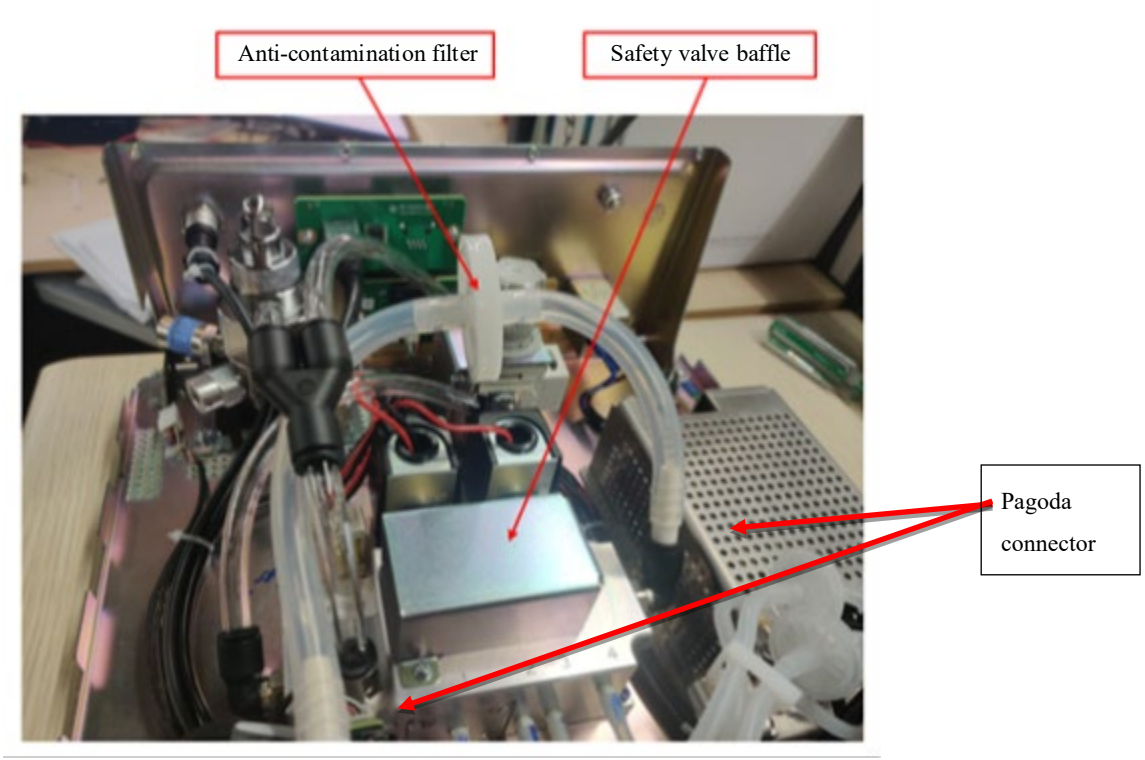


Figure 9-23 Disassembling the Anti-contamination Filter Assembly

9.22 Replacing the PU Hose

9.22.1 Tools

During part disassembly and replacement, the following tools may be used:

- Phillips screwdrivers

9.22.2 Preparations for Disassembly

/

9.22.3 Pre-disassembly

Remove the upper cover assembly. See 9.1.

9.22.4 Disassembly

As shown in Figure 9-24, after removing the PU hose from the quick-in connector (press the end of the quick-in connector inward to pull the PU hose out of the quick-in connector), you can replace the PU hose.

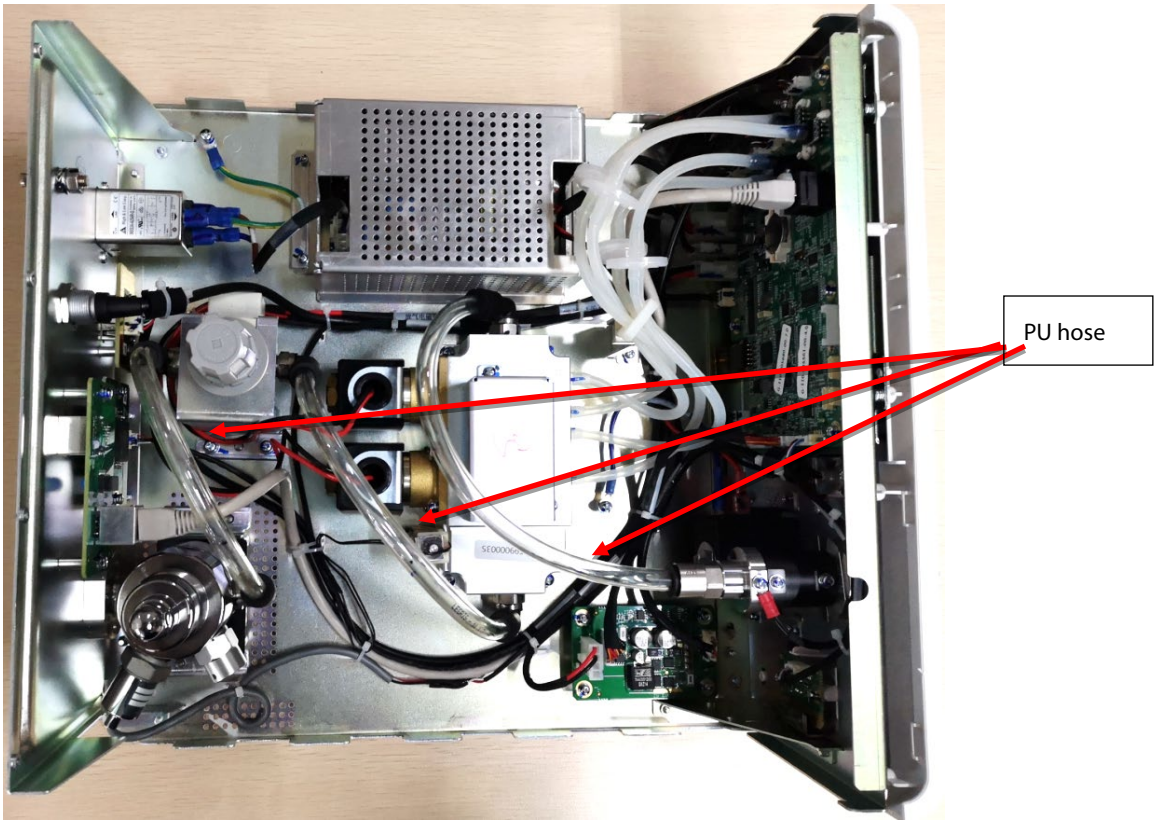


Figure 9-24 Replacing the PU Hose

9.23 Disassembling the Fuse

9.23.1 Tools

During part disassembly and replacement, the following tools may be used:

- Slot-type screwdrivers

9.23.2 Preparations for Disassembly

Disconnect power and gas source.

9.23.3 Pre-disassembly

/

9.23.4 Disassembly

Press the middle of the lower edge of the AC socket inlet with a flat screwdriver, and then tilt it outwards to pull out the fuse holder.

Figure 9-25 Disassembling the Fuse

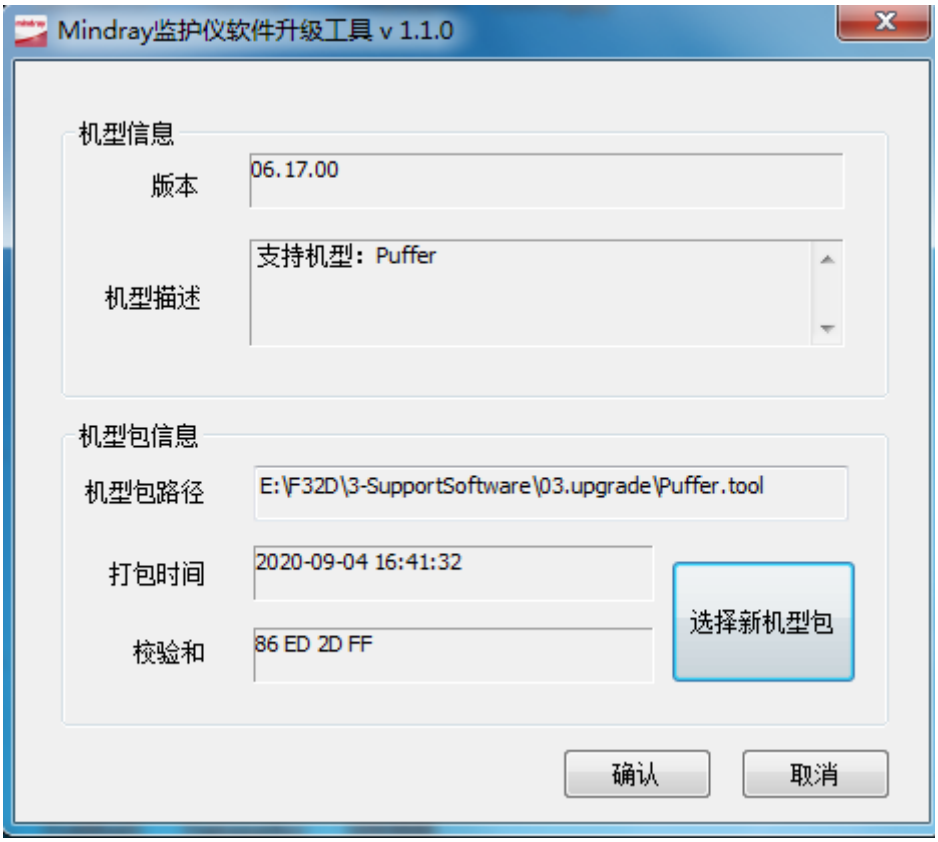
FOR YOUR NOTES

10 Software Upgrade

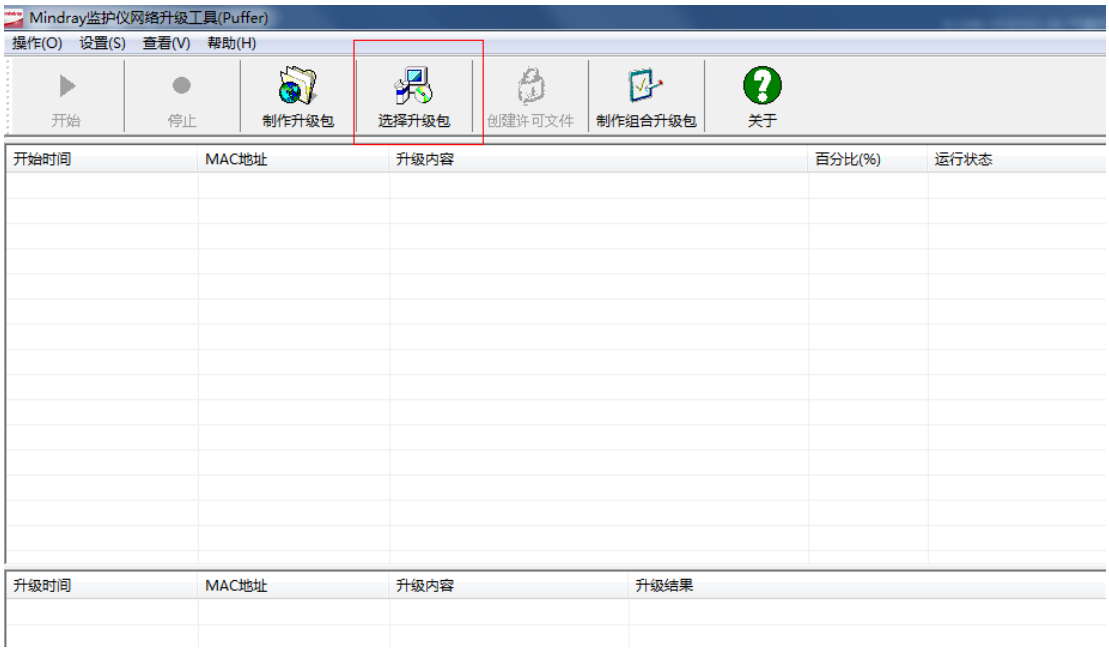
10.1 Network Upgrade

The network upgrade can be realized using the Mindray monitor network upgrade tool.

1. First set the PC IP address to 77.77.1.1xx. Connect the device and the PC directly with a network cable.
2. Open the Mindray monitor software upgrade tool, select the model package **Puffer.tool**.

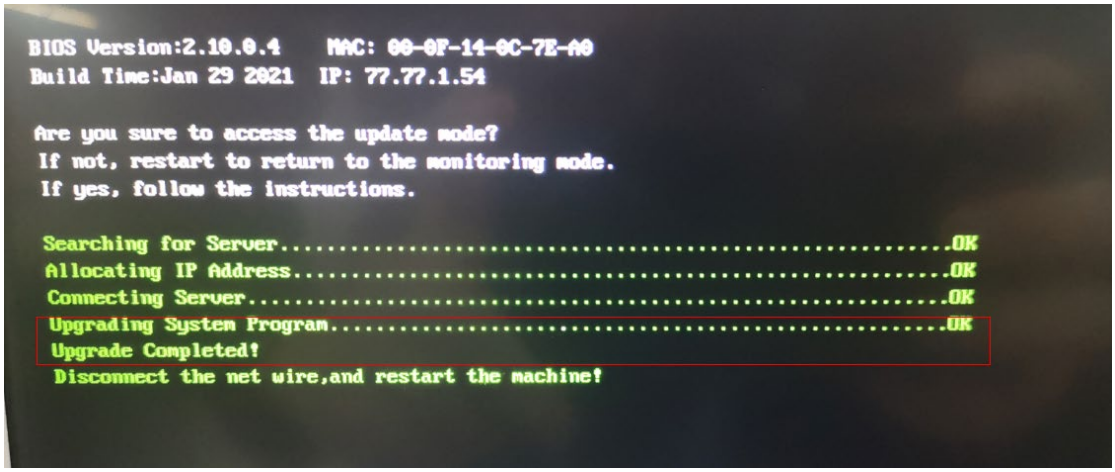


3. Select the file that needs to be upgraded (气腹机系统软件.mpkg).



4. Click **Start**, and then turn on the insufflator. The device automatically starts upgrading.

5. After the upgrade is complete, turn off the insufflator, unplug the network cable to complete the upgrade. The prompt of upgrade completion may be different.



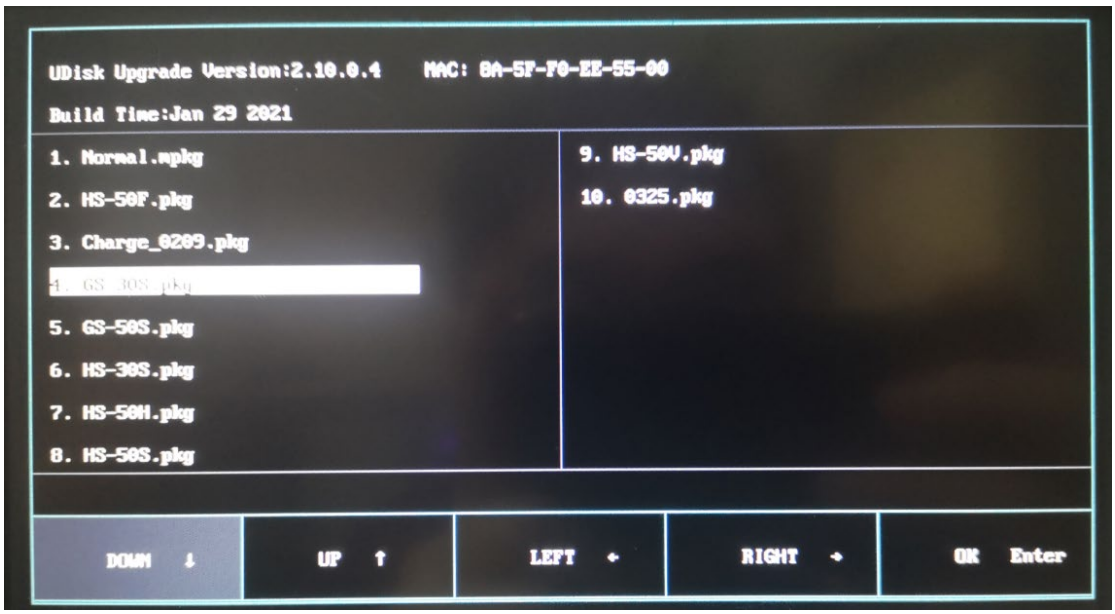
10.2 USB Flash Drive Upgrade

Only insufflator V2.0 can be upgraded through a USB flash drive. The upgrade procedure is shown as follows:

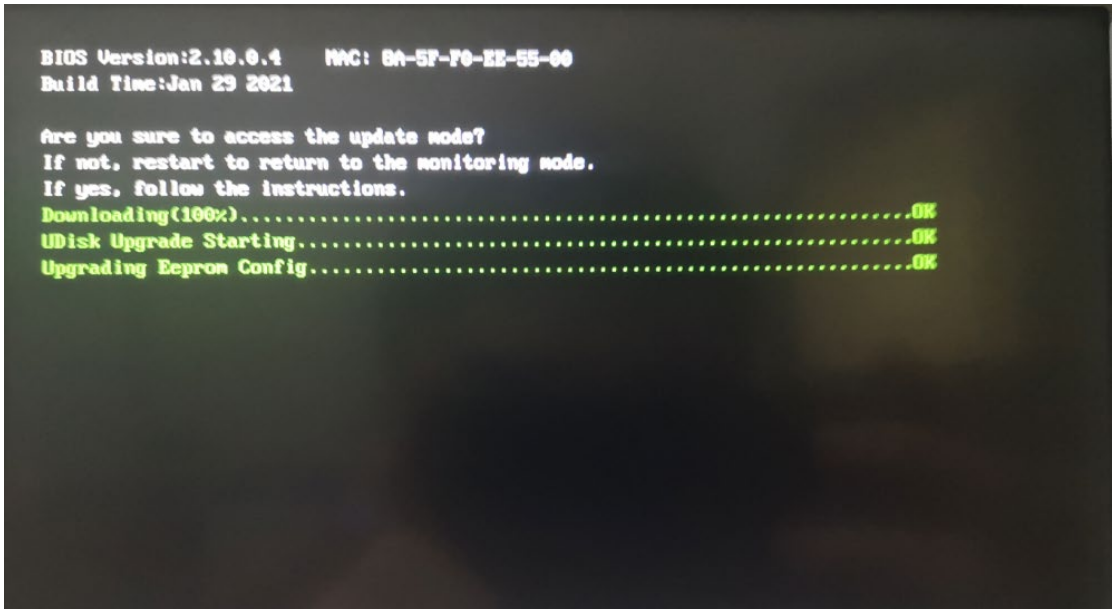
1. Get the USB flash drive: The general version system of the insufflator can be upgraded with a FAT32 format flash drive. Create a new **/UPGRADE_AMP/Puffer** directory in the USB flash drive,

and copy **Puffer_Installer.pkg** and the insufflator system software in the archived upgrade tool to the directory.

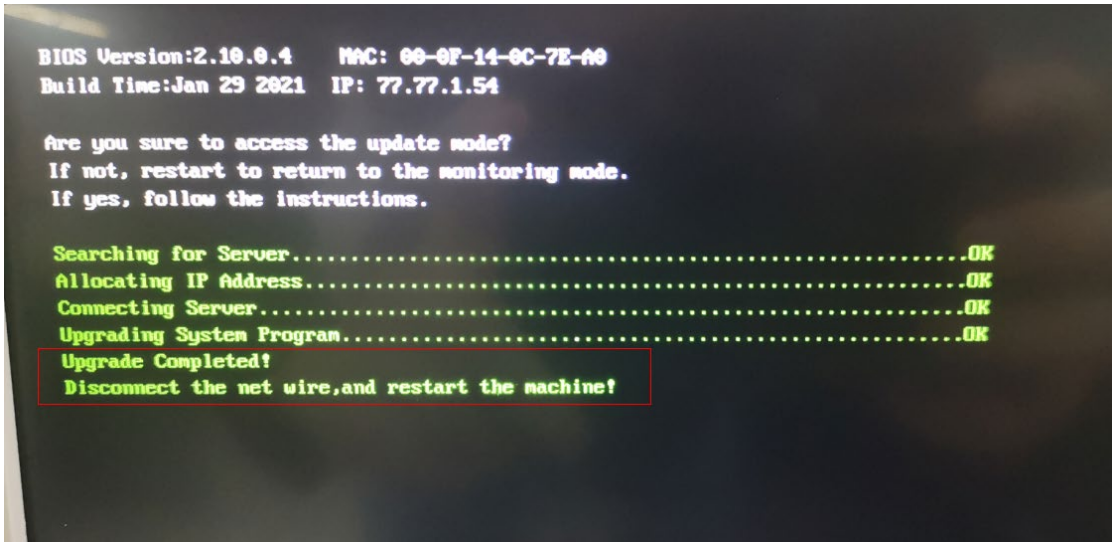
2. Insert the USB flash drive into the USB port on the rear panel of the insufflator system before booting. The insufflator will automatically enter the upgrade interface after booting. See the following figure.



3. Select **气腹机系统软件.mpkg**. Tap **OK** to start the upgrade.



After the upgrade is complete, the interface will display the following information:



4. Unplug the USB flash drive and restart the insufflator.

10.3 Calibration and Testing after Software Upgrade

10.3.1 Calibration, Setting, and Testing after Software Upgrade of V1.0 Insufflator

Calibration/ Setting/ Test items after maintenance	Reference section in the Service Manual	Calibration/Test completed
Touchscreen Calibration	6.1	□
High-Pressure Sensor Calibration	6.2	□
Flow Calibration	6.4	□
5.7.1 Setting Interface	5.7.1	□
Model	5.7.2.3	□
Time	0	□
Power-on self-inspection	7.3	□
Stress Accuracy Test	7.4.2	□
Flow accuracy test	7.4.3	□
Heating function test (optional)	7.4.4	□
Smoke exhaust function test (optional)	7.4.5	□
Gas source detection function test	7.4.6	□
Touchscreen Function Test	7.4.7	□

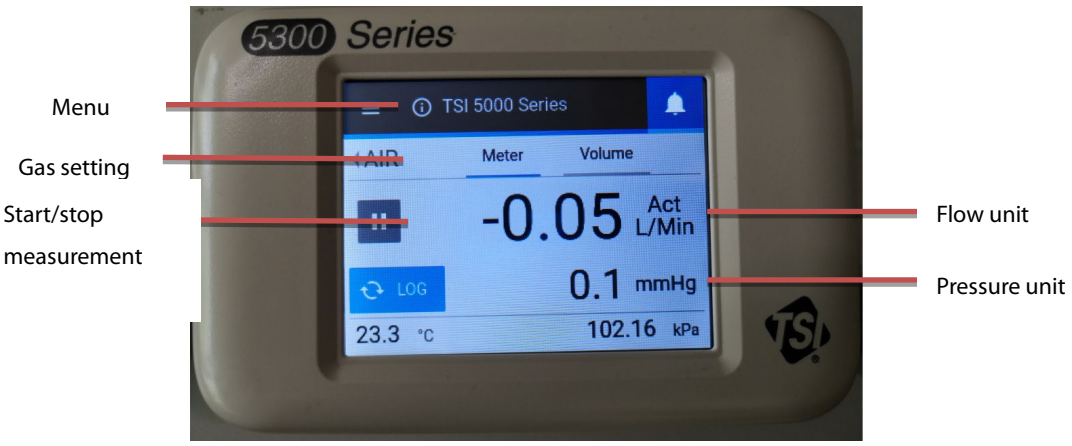
10.3.2 Calibration and Testing after Software Upgrade of V2.0 Insufflator

Calibration/test items after maintenance	Reference section in the Service Manual	Calibration/test completed
Power-on self-inspection	7.3	□
Inflation test	7.4.1	□
Heating function test (optional)	7.4.4	□
Smoke exhaust function test (optional)	7.4.5	□
Gas source detection function test	7.4.6	□
Touchscreen Function Test	7.4.7	□

FOR YOUR NOTES

A Instructions for Use of 5300 Flow Tester

Main interface of 5300 flow tester:



A.1 Selecting Gas Type

1) On the main interface, tap the gas **CO2** (may be other gases) displayed in the upper left corner to enter the gas selection interface:

2) Tap < and > to select the corresponding gas.

3) After completing the selection, tap **Save** and return to the main interface.

A.2 Zero Calibration of Pressure Sensor

1) Tap the "☰" menu in the upper left corner to enter the menu interface:

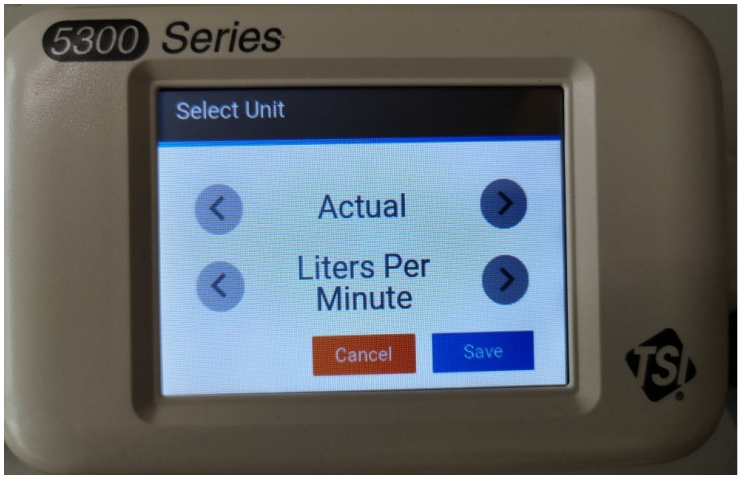
2) Select **Reset Device Settings** to enter the factory settings interface.

3) Tap **Zero Low Pressure** to complete the pressure sensor zero calibration.

4) After completing the zero calibration, tap the button in the upper left corner to enter the menu interface, and select **Meter/Volume** to return to the main interface.

A.3 Selecting Flow Unit

1) On the main interface, tap the flow unit on the right side of the display to enter the unit selection interface:



2) Tap < and > to select the corresponding flow unit type.

3) After completing the selection, tap **Save** and return to the main interface.

A.4 Selecting Pressure Unit

1) On the main interface, tap the pressure unit on the right side of the display to enter the unit selection interface:

2) Tap < and > to select the corresponding flow unit type.

3) After completing the selection, tap **Save** and return to the main interface.

FOR YOUR NOTES

B List of Figures and Tables

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