ePM 15/ePM 15A/ePM 15C
ePM 12/ePM 12A/ePM 12C
ePM 10/ePM 10A/ePM 10C

Patient Monitor

Service Manual

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Revision History

This manual has a revision number. This revision number changes whenever the manual is updated due to software or technical specification change. Contents of this manual are subject to change without prior notice.

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Preface

Manual Purpose

This manual provides detailed information about the assembling, dissembling, testing and troubleshooting of the equipment to support effective troubleshooting and repair. It is not intended to be a comprehensive, in-depth explanation of the product architecture or technical implementation. Observance of the manual is a prerequisite for proper equipment maintenance and prevents equipment damage and personnel injury.

Intended Audience

This manual is for biomedical engineers, authorized technicians or service representatives responsible for troubleshooting, repairing and maintaining the monitors.

Passwords

A password may be required to access different modes. The passwords are listed below:

- User maintenance: 888888
- Manage Configuration: 315666
- Factory maintenance: 332888
- Demo mode: 2088

Contents

1 Safety 1-1
1.1 Safety Information 1-1
1.1.1 Warnings 1-1
1.1.2 Cautions 1-2
1.1.3 Notes 1-3
1.2 Equipment Symbols 1-3

2 Product Principle 2-1
2.1 Overview 2-1
2.2 Product System Structure 2-1
2.2.1 Main Control Board/Parameter/Interface Board 2-2
2.2.2 Power Supply Architecture 2-3
2.2.3 Alarm Indicator Light Board 2-4
2.2.4 Power On/Off Button Board/Shortcut Button Board 2-4
2.3 Data Logic Flow 2-4
2.4 Power On/Off Signal Flow Diagram 2-5

3 Wireless LAN (WLAN) Installation 3-1
3.1 Introduction 3-1
3.2 Network Deployment Process 3-1
3.2.1 Output List 3-2
3.3 Network Requirements 3-3
3.4 Network Inspection and Acceptance 3-4
3.4.1 Tools and Resources 3-4
3.4.2 WiFi Signal Calibration 3-5
3.4.3 Network Inspection and Acceptance Process 3-5
3.5 Use Patient Monitors to Assess Network Coverage 3-8
3.6 Recommended Network Equipment 3-9
3.7 Seting the Wireless Parameters of the Patient Monitor 3-9
3.8 Troubleshooting 3-12

4 Testing and Maintenance 4-1
4.1 Introduction 4-1
4.1.1 Test Device 4-1
4.1.2 Test Report 4-1
4.1.3 Preventive Maintenance 4-1
4.1.4 Recommended Frequency 4-2
4.2 Preventive Maintenance 4-3
4.2.1 Visual Inspection 4-3
4.2.2 NIBP Test 4-3
4.2.3 Sidestream and Microstream CO_2 Testing and Calibration 4-6

4.3 Power On Test 4-8
4.4 Module Performance Test 4-9
4.4.1 ECG Test 4-9
4.4.2 Resp Test 4-9
4.4.3 SpO_2 Test 4-10
4.4.4 NIBP Test 4-10
4.4.5 Temp Test 4-10
4.4.6 IBP Test 4-11
4.4.7 C.O. Test 4-12
4.4.8 Mainstream CO_2 Test 4-13
4.4.9 Sidestream and Microstream CO_2 Testing and Calibration 4-14
4.5 Nurse Call Test 4-14
4.6 Analog Output Test 4-15
4.7 Electric Safety Test 4-15
4.7.1 Housing Leakage Current Test 4-16
4.7.2 Earth Leakage Current Test 4-16
4.7.3 Patient Leakage Current Test 4-17
4.7.4 Patient Auxiliary Current Test 4-17
4.8 Recorder Check 4-17
4.9 Network Printing Check 4-18
4.9.1 Equipment Connection and Setup 4-18
4.9.2 Printing Function Test 4-18
4.10 Battery Check 4-18
4.11 Charging Dock Check 4-19
4.12 Factory Maintenance 4-19
4.12.1 Enter Factory Maintenance 4-19
4.12.2 Monitor Iinformation (Exporting Log) 4-19
4.12.3 Production Test 4-19
4.12.4 Setup 4-20
4.12.5 Debugging 4-20
4.12.6 Power Information 4-20
4.12.7 Clinical Data 4-20
4.12.8 Sending Clinical Data 4-20
4.12.9 Software Version 4-20

5 Troubleshooting 5-1
5.1 Introduction 5-1
5.2 Component Replacement 5-1
5.3 Checkup before Starting the Monitor 5-1
5.4 Software Version Check 5-1
5.5 Technical Alarm Messages 5-1
5.5.1 General Technical Alarm Messages 5-2
5.5.2 ECG Technical Alarm Messages 5-2
5.5.3 Resp Technical Alarm Messages 5-3

5.5.4 SpO_2 Technical Alarm Messages....5-3
5.5.5 Temp Technical Alarm Messages....5-4
5.5.6 NIBP Technical Alarm Messages....5-4
5.5.7 IBP Technical Alarm Messages....5-5
5.5.8 C.O. Technical Alarm Messages....5-6
5.5.9 CO_2 Technical Alarm Messages....5-6
5.5.10 AG Technical Alarm Messages....5-8
5.5.11 BIS Technical Alarm Messages....5-8
5.5.12 Power Supply Technical Alarm Messages....5-9
5.5.13 Recorder Technical Alarm Messages....5-10
5.5.14 Printer Technical Alarm Messages....5-10
5.5.15 Technical Alarm Messages Related to Networked Monitoring....5-11
5.5.16 Other System Technical Alarm Messages....5-11
5.6 Troubleshooting Guide....5-12
5.6.1 Problems with Turning on/off....5-12
5.6.2 Display Failures....5-15
5.6.3 Alarm Failures....5-16
5.6.4 Recorder Failures....5-17
5.6.5 Output Interface Failures....5-17
5.6.6 Battery Failures....5-18
5.6.7 Parameter Module Failures....5-18
5.6.8 Network Failures....5-19
5.6.9 Software Upgrade Failures....5-20

6 Upgrade....6-1
6.1 Introduction....6-1
6.2 Parameter Function Module Upgrade....6-1
6.3 Upgrading Parameter C.O. Function Module....6-2
6.4 Upgrading the Gas Module....6-2
6.5 Function Component Upgrade....6-4
6.5.1 Upgrading WiFi Function....6-4
6.5.2 Upgrading Recorder Function....6-6
6.6 Software upgrade....6-7
6.6.1 Network Upgrade Tool....6-8
6.6.2 Software Upgrade....6-12
6.6.3 Upgrade by USB Disk....6-13

7 Maintenance and Disassembly....7-1
7.1 Tool....7-1
7.2 Preparations....7-1
7.3 ePM 15/ePM 15A/ePM 15C Host Disassembly....7-2
7.3.1 Disassembling Front/rear Housing Components of Host....7-2
7.3.2 Disassembling Keypad and Switch Board....7-3
7.3.3 Disassembling Display Screen and Alarm Indicator....7-3

7.3.4 Disassembling WiFi and Parameter Panel 7-7
7.3.5 Disassembling Gas Module 7-16
7.3.6 Disassembling Recorder/Recorder Bracket 7-17
7.3.7 Disassembling Main Bracket Component 7-18
7.3.8 Disassembling Speaker 7-19
7.3.9 Disassembling Rear Alarm Indicator (Configured) 7-20
7.3.10 Disassembling Power Module 7-20
7.3.11 Disassembling SpO_2 Module (When Nellcor/Massimo SpO_2 Is Configured) 7-21
7.3.12 Disassembling C.O. Board (Configured) 7-21
7.3.13 Disassembling Mainboard 7-22
7.3.14 Disassembling Power Adapter and NIBP Pump/Valve 7-24
7.4 ePM 12/ePM 12A/ePM 12C Host Disassembly 7-26
7.4.1 Disassembling Battery Box (Configured) 7-26
7.4.2 Disassembling Front/rear Housing Components of Host 7-27
7.4.3 Disassembling Front Housing Component 7-27
7.4.4 Disassembling Display Screen and Alarm Indicator 7-28
7.4.5 Disassembling WiFi and Parameter Panel 7-32
7.4.6 Disassembling Gas Module 7-41
7.4.7 Disassembling Recorder/Recorder Bracket 7-42
7.4.8 Disassembling Main Bracket Component 7-43
7.4.9 Disassembling Speaker 7-45
7.4.10 Disassembling Rear Alarm Indicator (Configured) 7-45
7.4.11 Disassembling Power Module 7-45
7.4.12 Disassembling SpO_2 Module (When Nellcor/Massimo SpO_2 Is Configured) 7-46
7.4.13 Disassembling C.O. Board (Configured) 7-46
7.4.14 Disassembling Mainboard 7-47
7.4.15 Disassembling Power Adapter and NIBP Pump/Valve 7-48
7.5 ePM 10/ePM 10A/ePM 10C Host Disassembly 7-50
7.5.1 Disassembling Front/rear Housing Components of Host 7-50
7.5.2 Disassembling Keypad 7-51
7.5.3 Disassembling Display Screen and Alarm Indicator 7-51
7.5.4 Disassembling WiFi and Parameter Panel 7-55
7.5.5 Disassembling Gas Module 7-64
7.5.6 Disassembling Recorder/Recorder Bracket 7-65
7.5.7 Disassembling Main Bracket Component 7-66
7.5.8 Disassembling Speaker 7-67
7.5.9 Disassembling Rear Alarm Indicator (Configured) 7-67
7.5.10 Disassembling Power Module 7-67
7.5.11 Disassembling SpO_2 Module (When Nellcor/Massimo SpO_2 Is Configured) 7-68
7.5.12 Disassembling C.O. Board (Configured) 7-69
7.5.13 Disassembling Mainboard 7-69
7.5.14 Disassembling Power Adapter and NIBP Pump/Valve 7-71
7.6 ePM T10 Vehicle-mounted Charger Base Disassembly 7-72
7.6.1 Disassembling Transfer Base 7-72

7.6.2 Disassembling Installation Base 7-74
7.6.3 Disassembling Adapter Component 7-75

8 Parts 8-1
8.1 ePM 15/ePM 15A/ePM 15C Parts 8-1
8.1.1 System Structure 8-1
8.1.2 Front Housing 8-2
8.1.3 Rear Housing 8-3
8.2 ePM 12/ePM 12A/ePM 12C Parts 8-4
8.2.1 System Structure 8-4
8.2.2 Front Housing 8-5
8.2.3 Rear Housing 8-6
8.3 ePM 10/ePM 10A/ePM 10C Parts 8-7
8.3.1 System Structure 8-7
8.3.2 Front Housing 8-8
8.3.3 Rear Housing 8-9

A Electrical Safety Inspection A-1
A.1 Power Cord Plug A-1
A.1.1 The Power Plug A-1
A.2 Device Enclosure and Accessories A-2
A.2.1 Visual Inspection A-2
A.2.2 Contextual Inspection A-2
A.3 Device Labeling A-2
A.4 Protective Earth Resistance A-2
A.5 Earth Leakage Test A-4
A.6 Patient Leakage Current A-5
A.7 Mains on Applied Part Leakage A-7
A.8 Patient Auxiliary Current A-9

FOR YOUR NOTES

1 Safety

1.1 Safety Information

⚠ WARNING

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

⚠ 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 Warnings

⚠ WARNING

- **This equipment is used for single patient at a time.**
- **This equipment and its accessories are suitable for use within the patient environment.**
- **To avoid explosion hazard, do not use the equipment in the presence of oxygen-rich atmospheres, flammable anesthetics, or other flammable agents.**
- **Use and store the equipment in specified environmental condition. The monitor and accessories may not meet the performance specification due to aging, stored or used outside the specified temperature and humidity range.**
- **The equipment is not intended to be used within the Magnetic Resonance (MR) environment.**
- **Before connecting the equipment to the power line, check that the voltage and frequency ratings of the power line are the same as those indicated on the equipment's label or in this manual.**
- **Before putting the system into operation, the operator must verify that the equipment, connecting cables and accessories are in correct working order and operating condition.**

- **To avoid risk of electric shock, the equipment must only be connected to mains power with protective earth. If a protective earth conductor is not provided, operate it on battery power, if possible.**
- **Do not use the multiple portable socket outlets (MPSO) or AC mains extension cords. Insure that the sum of the individual ground leakage currents does not exceed the allowable limits.**
- **Do not touch the patient and live parts simultaneously. Otherwise patient injury may result.**
- **Do not come into contact with the patient during defibrillation. Otherwise serious injury or death could result.**
- **Do not open the equipment housings. All servicing and future upgrades must be carried out by trained and authorized personnel.**
- **Do not rely exclusively on the audible alarm system for patient monitoring. Turning the alarm volume to a low level or off may result in a hazard to the patient. Remember that alarm settings should be customized according to patient situations. Always keep the patient under close surveillance.**
- **The physiological data and alarm messages displayed on the equipment are for reference only and cannot be directly used for diagnostic interpretation.**
- **Route, wrap and secure the cables to avoid inadvertent disconnection, stumbling and entanglement.**
- **The software equipment copyright is solely owned by Mindray. No organization or individual shall resort to modifying, copying, or exchanging it or to any other infringement on it in any form or by any means without due permission.**

1.1.2 Cautions

⚠ CAUTION

- **Use only parts and accessories specified in this manual.**
- **Ensure that the equipment is supplied with continuous electric power during work. Sudden power failure may cause data loss.**
- **Magnetic and electrical fields are capable of interfering with the proper performance of the equipment. For this reason make sure that all external devices operated in the vicinity of the equipment comply with the relevant EMC requirements. Mobile phone, X-ray equipment or MRI devices are a possible source of interference as they may emit higher levels of electromagnetic radiation.**
- **Always install or carry the equipment properly to avoid damage caused by drop, impact, strong vibration or other mechanical force.**
- **Dry the equipment immediately in case of rain or water spray.**
- **Some settings are password protected and can only be changed by authorized personnel. Contact your department manager or biomedical engineering department for the passwords used at your facility.**

- **Dispose of the package material as per the applicable waste control regulations. Keep it out of children's reach.**
- **At the end of its service life, the equipment, as well as its accessories, must be disposed of in compliance with the guidelines regulating the disposal of such products. If you have any questions concerning disposal of the equipment, please contact us.**

1.1.3 Notes

NOTE

- **Put the equipment in a location where you can easily view and operate the equipment.**
- **The equipment use a mains plug as isolation means to the mains power. Do not locate the equipment in a place difficult to operate the mains plug.**
- **The typical operator's position is in front of the monitor.**
- **The software was developed in compliance with IEC62304. The possibility of hazards arising from software errors is minimized.**
- **This manual describes all features and options. Your equipment may not have all of them.**
- **Keep this manual in the vicinity of the equipment so that it can be obtained conveniently when needed.**

1.2 Equipment Symbols

See the ***ePM Series Patient Monitor Operator's Manual (P/N: 046-012606-00)*** for information about the symbols used on this product and its packaging.

FOR YOUR NOTES

2 Product Principle

2.1 Overview

The ePM series multi-parameter monitors enable to provide complete patient management, adequate physiological parameter monitoring and physiological alarm, possessing powerful data review function, flexible wired or wireless network configuration and application ability. It provides a series of CAA applications to assist physicians to make a diagnosis. Meanwhile, the ePM series provide hospital management with superior monitor management applications to help hospitals to improve the efficiency and quality of monitor equipment management.

Based on the needs of clinical applications, ePM series could provide product models with displays of different sizes. Users can operate the monitor by touch screen or shortcut key.
The ePM series have good human-computer interaction design, clinical applicability, complete hospital IT solution capabilities and lots of CDS applications.

2.2 Product System Structure

The ePM series monitors have only one main unit:

- ePM 10/ePM 10A/ePM 10C host uses 10.1" TFT WXGA display
- ePM 12/ePM 12A/ePM 12C host uses 12.1" TFT WXGA display
- ePM 15/ePM 15A/ePM 15C host uses 15.6" TFT WXGA display
- Both of them use a touch screen and shortcut buttons as input devices, with an optional remote control
- Optional WiFi module
- Optional built-in recorder

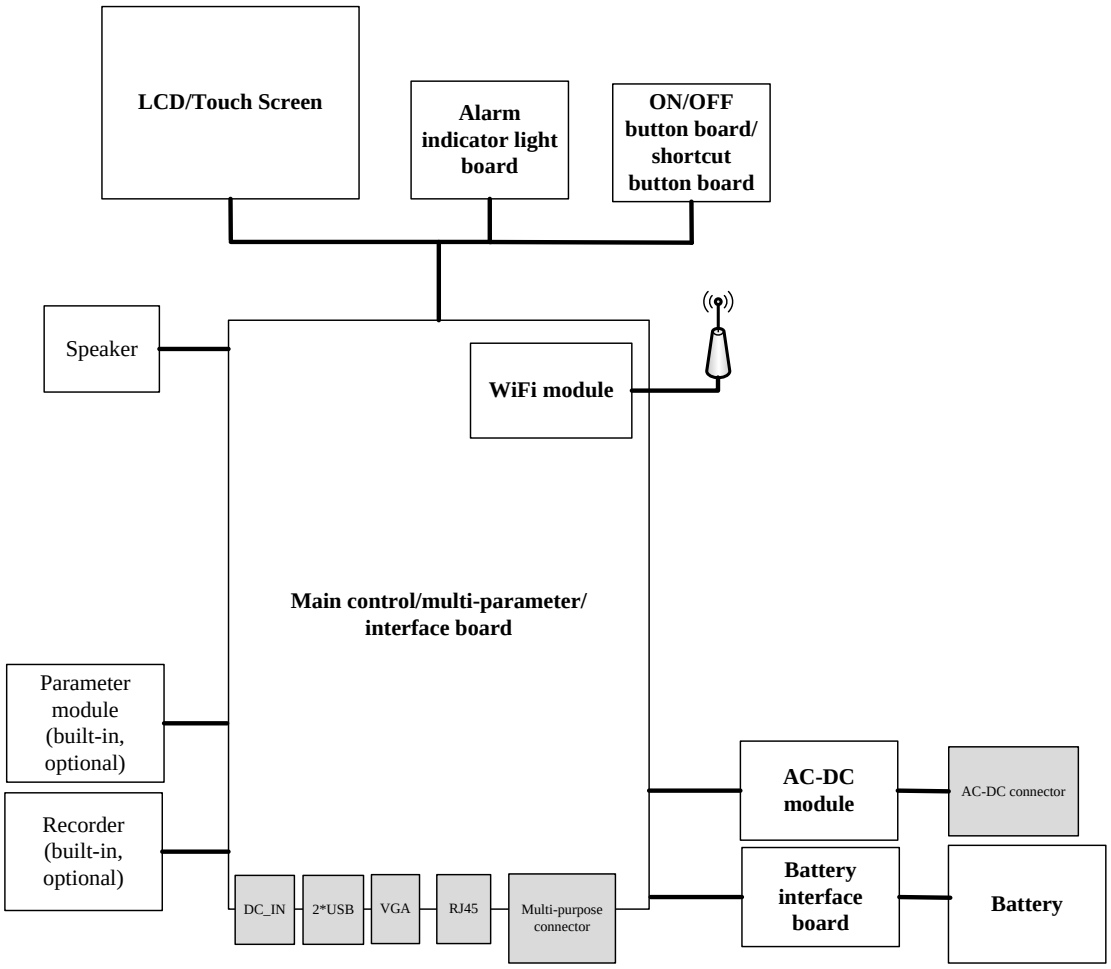


Fig. 1- 1 System Block Diagram

2.2.1 Main Control Board/Parameter/Interface Board

The main control board includes the main control CPU, program memory, data memory, system configuration memory, WiFi module (optional), power management MCU, charging circuit for batteries and DC-DC circuit. A multi-parameter module circuit (ECG/Resp/SpO_2/NIBP/IBP) is also integrated on this board. In addition, there are internal and external interfaces. The internal interfaces include an interface for the recorder, an internal parameter module interface, an interface between the AC-DC and the battery. The external interfaces include a VGA display interface, a USB interface, an Ethernet interface and a multi-function interface. (There is an additional DC_IN interface for ePM 10/ePM 10A/ePM 10C).

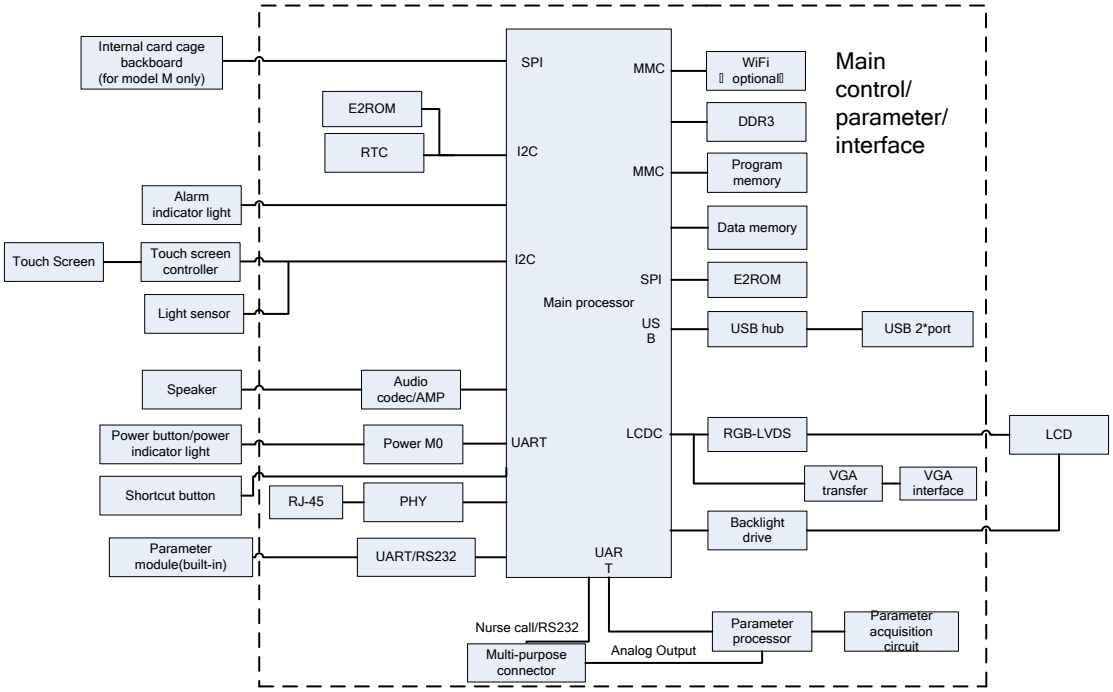


Fig. 1-2 Main Control Board Block Diagram

2.2.2 Power Supply Architecture

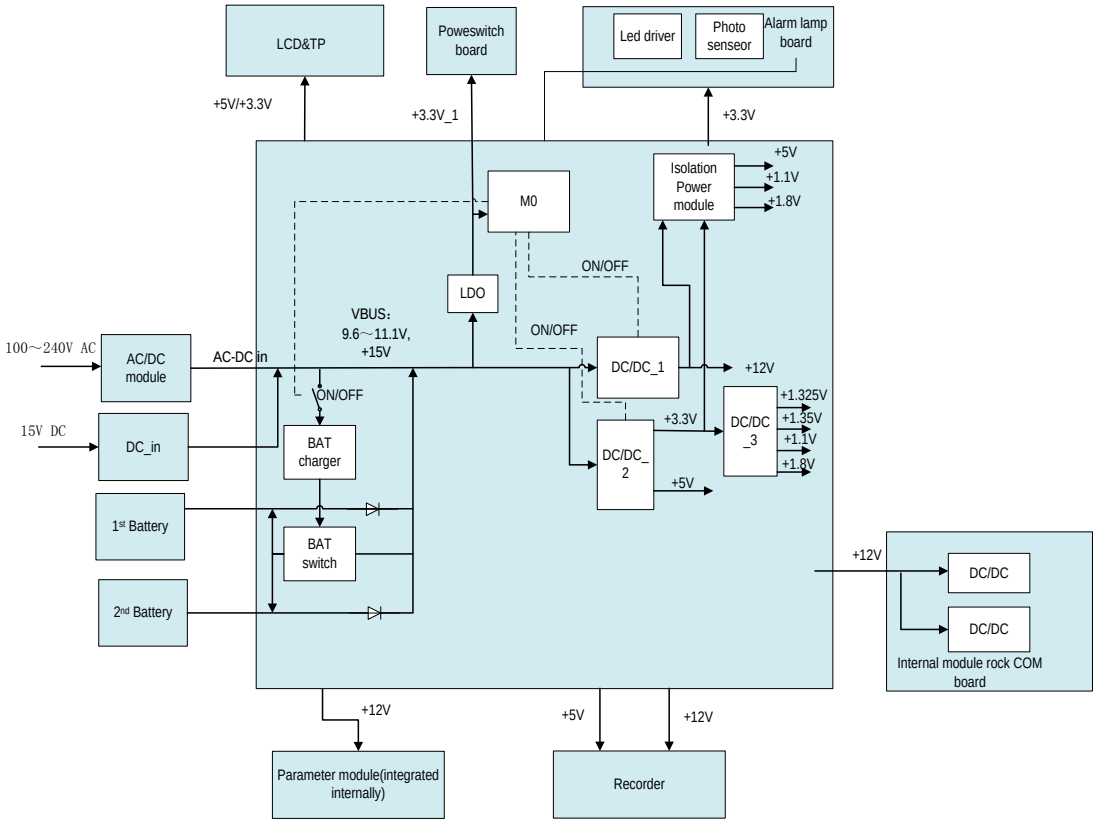


Fig. 1-3 Power Supply Architecture Diagram

The AC/DC power module outputs 15V to the main control board. By the internal DC-DC_2 and DC_DC_1 conversion circuits of the main control board, it can generate 3.3V, 5V and 12V to supply power for other modules or boards in the host. The battery charging circuit is powered by 15V and can be switched between AC power supply and battery power supply by AC connection test. The ePM12/ePM 12A/ePM 12C can support dual batteries. The first battery is installed in the main unit and the second battery is installed in the external battery compartment. The external battery compartment is installed at the bottom of the main unit. For the ePM15/ePM 15A/ePM 15C, the internal battery compartment can support two batteries. The ePM Series monitors support 3 types of batteries, 2600mAh, 4500mAh and 5600mAh. 2600mAh and 4500mAh are interchangeable. 5600mAh cannot be used interchangeably with these two batteries. The ePM 10/ePM 10A/ePM 10C can be mounted to an ambulance via a charging dock. There is an isolated power module in the charging dock which converts the 28~12V input to a 15V output. The output of the charging dock is connected to the DC_in interface of the ePM 10/ePM 10A/ePM 10C. +12V is the power supply for the integral module rack, recorder and parameter acquisition circuit. The power module for parameter acquisition adopts the DC-DC isolation design. DC_DC_3 is used to power the main processor.

2.2.3 Alarm Indicator Light Board

There are LED alarm indicator lights and light sensors (optional) on the board. The light sensors conduct ambient light detection in order to adjust the brightness of LCD background light.

2.2.4 Power On/Off Button Board/Shortcut Button Board

For the power switches, indicator lights and shortcut buttons are integrated on one board.

2.3 Data Logic Flow

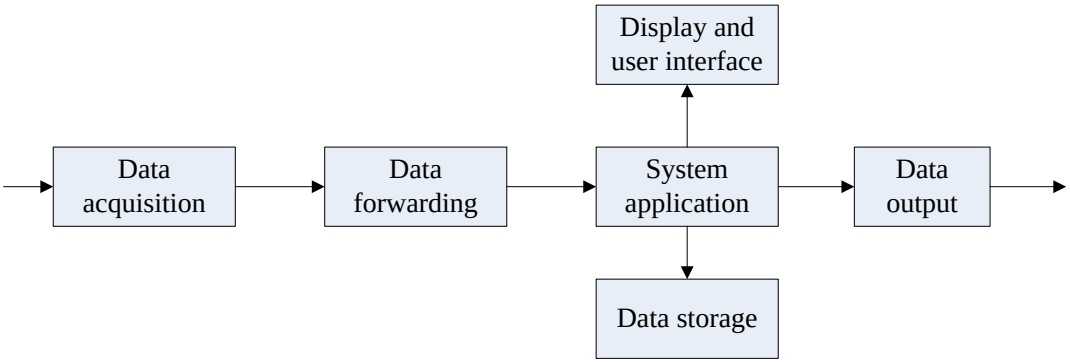
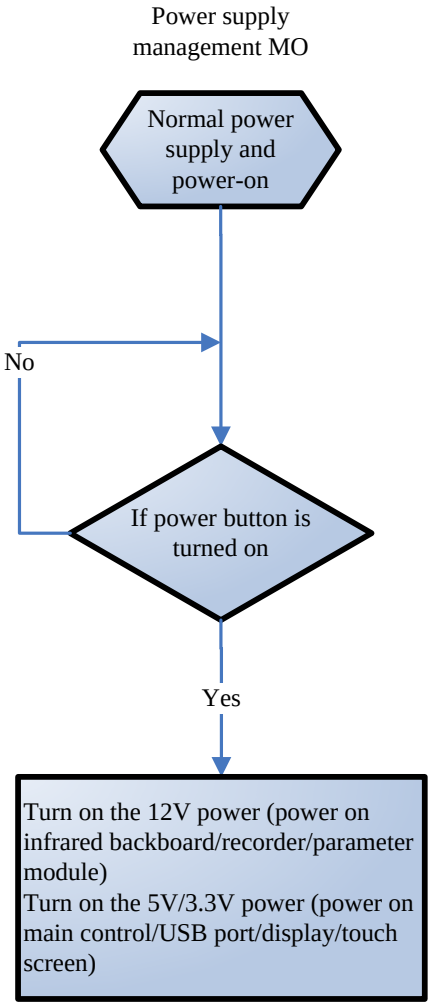


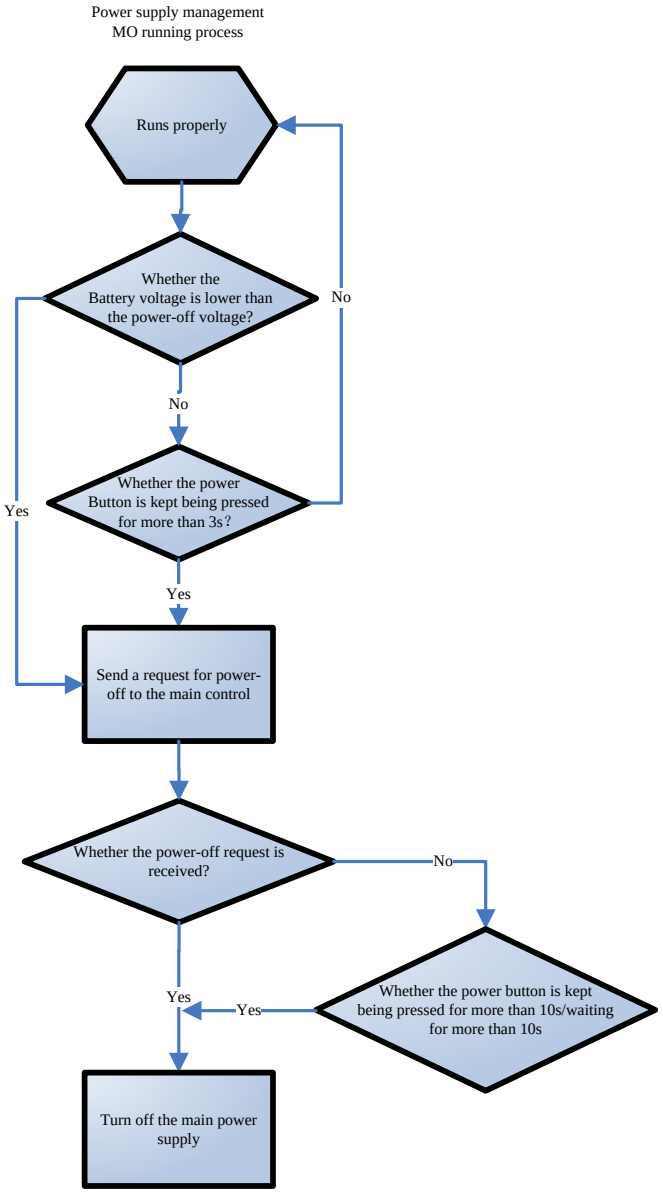
Fig.2- 3 Data Flow Diagram

The monitoring parameters are collected and analyzed by the module and then forwarded to the system software via an integral or external module rack. The system software displays waveforms, values and alarms, meanwhile the data, alarms and values will also be stored in the internal data memory. It can also be sent to a central station or other monitors via network (wired or wireless).

2.4 Power On/Off Signal Flow Diagram



Power ON/OFF chart



Power OFF process.

3 Wireless LAN (WLAN) Installation

3.1 Introduction

This section describes how to install the Wireless LAN (WLAN) for Mindray patient monitor.

3.2 Network Deployment Process

If the hospital has established a WLAN, follow the installation process below:

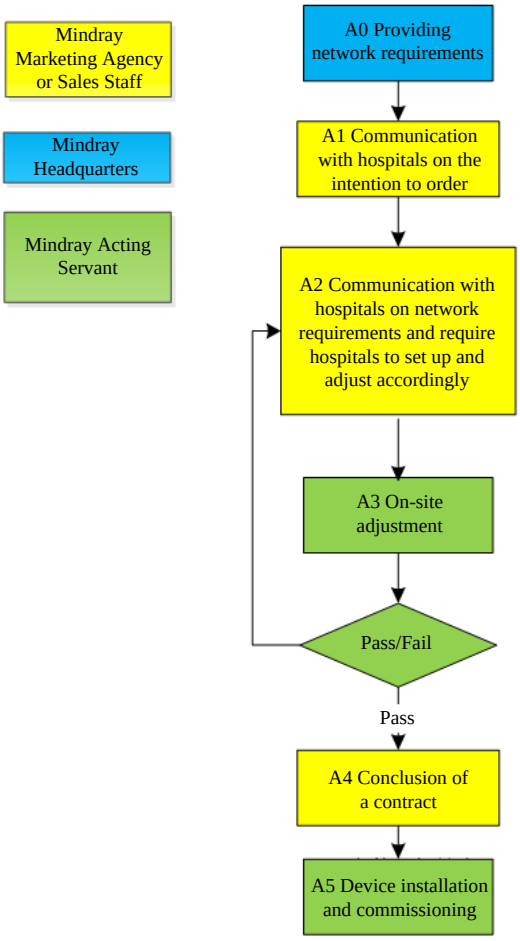


Fig. 3-1 Network deployment flow chart

3.2.1 Output List

Operation	Output	Acceptance Criteria	Template
A0	Wireless network requirements for Mindray patient monitor	Determine the wireless network deployment requirements for the Mindray patient monitor.	Wireless network requirement table
A3	Network inspection and acceptance report	Confirm whether the customer network meets the requirements of the Mindray patient monitor by questionnaires and measurements.	Wireless network inspection and acceptance table
A5	Installation confirmation report	Confirm the actual operation of the Mindray patient monitor after installation.	Installation confirmation table for patient monitor

If the hospital plans to create a new WLAN for the Mindray patient monitor, make sure there is at least one WiFi channel that is not in use. Otherwise, after establishing a new WLAN, it is impossible to meet the requirements of the Mindray patient monitor in terms of co-channel interference. See the installation process below:

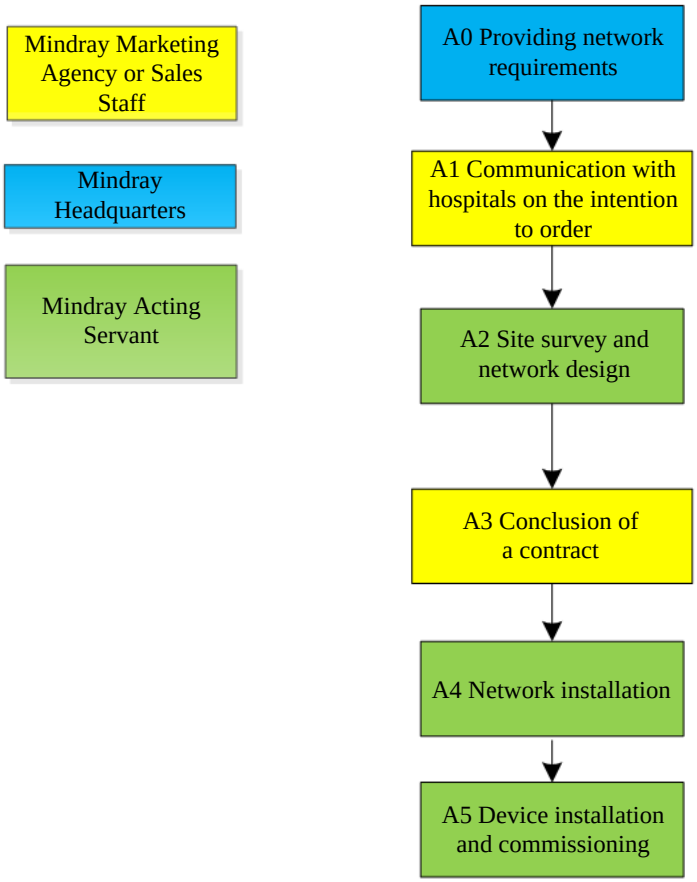


Fig. 3-2 New WLAN installation process

Operation	Output	Acceptance Criteria	Template
A0	Wireless network requirements for Mindray patient monitor	Determine the wireless network deployment requirements for the Mindray patient monitor.	Wireless network requirement table
A2	Network design document, list of materials	/	/
A5	Installation confirmation report	Confirm the actual operation of the Mindray patient monitor after installation.	Installation confirmation table for patient monitor

Precautions

- **Network design and deployment engineering are complex and need a professional IT engineer to help get the job done. This document does not contain these contents.**

3.3 Network Requirements

The wireless network needs to meet the following requirements.

Table 3-1 Wireless network requirement table

No.	Item	Specific requirements
Wireless coverage requirements		
1	WiFi coverage signal strength (RSSI)	-65dBm RSSI is the value displayed on the patient monitor
2	Co-channel interference	20dB (co-channel interference AP signal is at least 20dB lower than the AP signal used by the monitor)
3	Ping latency	The average latency of a PC or mobile phone is less than 100 milliseconds and the packet loss rate should be lower than 1%.
AP capability requirements		
1	AP capability	The expected number of devices connected to an AP must be less than 50% of the AP capacity. For example, within the coverage of an AP, usually there are 16 devices connected to the AP, so the entitled number of devices that are allowed to be connected to the AP at the same time must be greater than 32. An AP can create multiple SSIDs.
2	Equipment density	The maximum number of devices that can be connected to an AP at the same time is 16. (including patient monitors and other equipment).
WLAN features		

No.	Item	Specific requirements
1	AP channel width	Set the AP channel width to 20MHz. Do not use the HT40 or HT80.
2	802.11 protocol	The WLAN cannot use protocols that are not supported by the Mindray patient monitor, such as 802.11ac
3	Security mode	The WLAN cannot use the security mode that is not supported by the Mindray patient monitor. WPA2-PSK is highly recommended. WPA2-Enterprise may increase the off-line probability while roaming, so it is not recommended.
4	Virtual local area network for special use (VLAN)	The patient monitor requires a special VLAN. The use of VLAN can minimize the broadcast or multicast data that may affect the stability of patient monitor.
Key settings		
1	DHCP	The DHCP server needs to keep a sufficient number of IP addresses to ensure that the patient monitor can obtain an IP address.
2	IGMP snooping	Enable IGMP snooping if the patient monitor adopts multicast
3	Multicast	If the patient monitor adopts multicast, the network multicast function should be enabled.
4	Beacon and DTIM	AP DTIM = 1, Beacon = 100 milliseconds
5	Service port	See the Mindray Patient Monitor Network White Paper; require network devices to turn on certain TCP/UDP ports for patient monitors

3.4 Network Inspection and Acceptance

3.4.1 Tools and Resources

- A laptop with Windows 7 (or a later version) and a wireless network card installed. It is recommended that the laptop be equipped with an Intel Centrino wireless adapter. If your laptop is configured with a different wireless adapter, make sure it has high precision.
- In terms of wireless network survey tools, it is recommended to use professional survey tools such as Tamograph, Wirelessmon or other professional network survey tools.
- Professional network engineer.

Precautions

- **Those who implement WiFi network surveys should have received good training on WiFi. If you do not have a professional network engineer, please ask a third party for help.**

3.4.2 WiFi Signal Calibration

Before testing network coverage by the use of a wireless network survey tool that runs on a laptop, follow the steps below to use the patient monitor to calibrate the RSSI of the wireless network survey tool.

1. Keep the patient monitor close to the wireless network survey tool. The distance between the patient monitor and the wireless network survey tool should not exceed 30cm and the distance from a human body should exceed 50cm.
2. Simultaneously move the patient monitor and wireless network survey tool (keep the same distance as before).
3. When the patient monitor displays the following RSSI values: -50dBm, -60dBm, -70dBm, and -80dBm, record the RSSI value read by the wireless network survey tool.
4. When conducting a site survey, calibrate the RSSI of the wireless network survey tool relative to the patient monitor (the RSSI of the patient monitor is the judge criterion for wireless coverage).

3.4.3 Network Inspection and Acceptance Process

This is done in two ways: First, complete the project that requires the hospital IT department to conduct self-test, as shown in the network inspection and acceptance table. Then, the customer service personnel or authorized party will conduct site test and confirm the remaining contents, and finally fill in the network inspection and acceptance table. If any items are found to be non-conformed during the network inspection and acceptance, adjust them before installing the patient monitor.

During the testing, need to enable the WiFi network SSID broadcast to ensure that the SSID of the WiFi can be scanned.

Table 3-2 Wireless network inspection and acceptance table

No.	Item	Specific requirements	Inspection and acceptance method	Inspection results
Wireless coverage requirements				
1	Received signal strength(RSSI)	≥ -65dBm RSSI is the value displayed on the patient monitor	Service personnel use the network survey tool to perform tests. Be sure to test all expected coverage areas (such as wards, corridors, toilets, stairs and elevators).	
2	Co-channel interference	-20dB	Service personnel use the network survey tool to perform tests. Be sure to test all expected coverage areas (such as wards, corridors, toilets, stairs and elevators).	

No.	Item	Specific requirements	Inspection and acceptance method	Inspection results
3	Ping latency	The average latency of a PC or mobile phone using a normal WiFi module is less than 100 milliseconds and the packet loss rate should be lower than 1%.	Steps for the service personnel to perform the test: 1. Connect your PC or mobile phone to the AP. 2. Connect another PC to the LAN port to which the central monitoring system is connected. 3. Run the "ping –t –l 32 –w 1000 IPaddress-of -cellphone" command for 10 minutes. 4. Run "ctrl+c".	
AP capacity requirements				
1	AP capability	The expected number of devices connected to an AP must be less than 50% of the AP capacity. For example, within the coverage of an AP, usually there are 16 devices connected to the AP, so the entitled number of devices that are allowed to be connected to the AP at the same time must be greater than 32. An AP can create multiple SSIDs.	Service personnel obtain the AP model number from hospital personnel or by direct observation. Obtain an AP data manual as per this model number to confirm related AP capabilities.	
2	Equipment density	The maximum number of devices that can be connected to an AP at the same time is 12 (including patient monitors and other devices).	Check together with hospital IT personnel to confirm whether this requirement is met.	
WLAN features				
1	AP channel width	Set the channel width to 20MHz. Do not use the HT40 or HT80.	Check together with hospital IT personnel to confirm whether this requirement is met.	

No.	Item	Specific requirements	Inspection and acceptance method	Inspection results
2	802.11 protocol	The WLAN cannot use protocols that are not supported by the Mindray patient monitor, such as 802.11ac	Check together with hospital IT personnel to confirm whether this requirement is met.	
3	Security mode	The WLAN cannot use the security mode that is not supported by the Mindray patient monitor. WPA2-PSK is highly recommended. WPA2-Enterprise may increase the off-line probability while roaming, so it is not recommended.	Check together with hospital IT personnel to confirm whether this requirement is met.	
4	Virtual local area network for special use (VLAN)	The patient monitor requires a special VLAN. The use of VLAN can minimize the broadcast or multicast data that may affect the stability of patient monitor.	Check together with hospital IT personnel to confirm whether this requirement is met.	
Key settings				
1	DHCP	The DHCP server needs to keep a sufficient number of IP addresses to ensure that the patient monitor can obtain an IP address.	Check together with hospital IT personnel to confirm whether this requirement is met.	
2	IGMP snooping	Enable IGMP snooping if the patient monitor adopts multicast	Check together with hospital IT personnel to confirm whether this requirement is met.	
3	Multicast	If the patient monitor adopts multicast, the network multicast function should be enabled.	Check together with hospital IT personnel to confirm whether this requirement is met.	
4	Beacon and	AP DTIM = 1, Beacon =	Check together with hospital	

No.	Item	Specific requirements	Inspection and acceptance method	Inspection results
	DTIM	100 milliseconds	IT personnel to confirm whether this requirement is met.	
5	Service port	See the Mindray Patient Monitor Network White Paper; need to keep certain TCP/UDP ports open for patient monitors	Check together with hospital IT personnel to confirm whether this requirement is met.	

3.5 Use Patient Monitors to Assess Network Coverage

To confirm the coverage, perform a coverage test in the areas where patients often go around.

Confirm whether the coverage meets the requirements by observing the signal strength (RSSI) displayed on the patient monitor and whether an off-line event occurs.

If necessary, adjust the AP position or increase APs to ensure adequate coverage.

Please follow the steps below:

1. Set the patient monitor to access the central monitoring system.
2. Perform a Ping command on the patient monitor via the central monitoring system (enter "ping – t – l 32 – w 1500 IP address" in the CLI window) (continue to run the Ping command on the patient monitor. The data packet is 32 bytes and the reply timeout is 1500 milliseconds). Ten minutes later, enter "ctrl + c" (complete Ping) to ensure that the average latency is less than 250 milliseconds and the packet loss rate should be lower than 1%.
3. Hold the patient monitor by hand and avoid being held up by other people. Walk around the expected coverage areas (such as wards, toilets, smoking areas, corridors, and all corners of the elevator).
4. The number of disconnections from the central station should be less than 10% of the roaming times of the patient monitor, and the RSSI value displayed on the patient monitor should not be lower than -65dBm.
5. If the signal strength is below -65dBm while walking around, stop walking at that location and observe for 30 seconds. If the RSSI value is not lower than -65dBm for more than 66% of the time, then it meets the coverage requirements.

Table 3-3 Installation confirmation table for patient monitor

Testing or observing items	Results (pass, fail or not applicable)
Perform a Ping command on the patient monitor via the central monitoring system and ensure that the average latency is less than 250 milliseconds and the packet loss rate should be lower than 1%.	
Hold the patient monitor by hand and walk around different AP coverage areas. After walking around all the expected coverage areas, observe the continuous waveforms on the central monitoring system. The off-line time should be less than 10% of the patient monitor's roaming time.	
In the position of worst coverage, the signal strength displayed on the screen is higher than -65dBm.	

Precautions

- **If the monitor is assessed only for use in a fixed position instead of roaming among various APs, then it's unnecessary to walk around coverage area during testing. It is only necessary to place the monitor at the possible installation position of the worst signal, and then confirm the signal strength and Ping effect.**

3.6 Recommended Network Equipment

The Cisco devices listed in the table below are recommended.

Device	Parts No.
2500 wireless controller	AIR-CT2504-x-K9
2600 wireless APs	AIR-CAP2602I-x-K9

3.7 Seting the Wireless Parameters of the Patient Monitor

Configure the patient monitor's WLAN parameters as per the table below:

Parameters	Settings recommended	Remarks
[Main Menu] → [Maintenance] → [User Maintenance] → [Network Setup] → [WLAN]		
SSID	Set the actual network name to be used	/
Security mode	WPA2-PSK	The security mode should be the same as that of the WLAN deployed for the patient monitor. If you are using EAP, choose the security mode based on your WLAN deployment.
Password	Set the actual network password to be used.	/
[Main Menu] → [Maintenance] → [User Maintenance] → [Network Setup] → [WLAN]→ [WLAN Setup]		

Parameters	Settings recommended	Remarks
WLAN frequency band	5G	The options include: 2.4G, 5G and Auto. 2.4G = use only 2.4GHz band 5G = use only 5GHz band Auto = use 2.4GHz and 5G Hz bands (5GHz shall prioritize)
ID verification server type	ACS	Options include: ACS and SBR. ACS refers to the Cisco access control server. SBR refers to other servers except ACS. It applies only when the security type is Enterprise.
BG channel	Designate	The options include: All, Designate and None. Stability and roaming performance can be improved by limiting the number of channels that the monitor can be connected to. For example, on a 2.4GHz network, set the channels to 1, 6, and 11, then the network card will not scan or connect to other channels. The BG channel settings on the patient monitor must match the AP channel settings.
Channel A	Designate	The options include: All, Designate and None. Stability and roaming performance can be improved by limiting the number of channels that the monitor can be connected to. The 5GHz channel settings on the patient monitor must match the WLAN AP channel settings.
[Main Menu] → [Maintenance] → [User Maintenance] → [Network Setup] → [WLAN] → [Certificate Management]		
Local	/	Display the existing EAP certificate in patient monitor
USB driver	/	Display the existing EAP certificate in the USB driver
[Main Menu] → [Maintenance] → [Factory Maintenance] → [Setup] → [WLAN Setup]		
Adjustment area	International area	South Korea, Turkey, Russia and Brazil need to be configured separately. Other countries/regions only need to choose international area. The patient monitor needs to be restarted for the patient monitor settings to take effect.
CCX features	Support	This means it supports CCX 4.0 and fast roaming
PMK cache	Criteria	The options include: Standard and OPMK. The option of Standard refers to PMK cache. OPMK refers to random key cache.
Trigger	-70	When the RSSI is below the roam trigger value, the network card will attempt to roam.
Scan cycle	5	When the RSSI is below the roam trigger value, the probe request cycle is 5 seconds.

The security modes supported by the monitor include:

menu	Basic algorithm	Authentication mode	Encryption mode	Whether support CCKM
WPA PSK	WPA	PSK	TKIP/RC4	No
WPA2 PSK	WPA2	PSK	CCMP/AES	No
WPA PSK AES	WPA	PSK	CCMP/AES	No
WPA TKIP	WPA	EAP	TKIP/RC4	No
WPA2 AES	WPA2	EAP	CCMP/AES	No
WPA AES	WPA	EAP	CCMP/AES	No
CCKM TKIP	CCKM	EAP	TKIP/RC4	Yes
CCKM AES	CCKM	EAP	CCMP/AES	Yes

After the EAP authentication mode is selected, the system will display corresponding configuration items. The table below lists the configuration items for different EAP methods.

	Identity	Anonymous	Password	CA certificate	User certificate	PAC certificate	PAC Password
PEAP-MSCHAPV2	Y	O	Y	Y	N	N	N
PEAP-GTC	Y	O	Y	Y	N	N	N
PEAP-TLS	Y	O	Y	Y	Y	N	N
TTLS	Y	O	Y	Y	N	N	N
TLS	Y	N	Y	Y	Y	N	N
FAST	Y	O	Y	N	N	Y	Y
LEAP	Y	N	Y	N	N	N	N

Remarks: Y means "yes", N means "no", and O means "optional".

The meaning of each configuration item is shown below:

- Identity Verification Protocol (Phase 2 Identity Verification): When PEAP in the EAP method is selected, the user can configure the following PEAP internal methods: EAP-MSCHAPV2, EAP-GTC and EAP-TLS.
- Identity: user identity, i.e. the user name in AD, LDAP, or local user management of the RADIUS server.
- Anonymous: This item does not affect the identity verification process. The function of this item is to hide the real name (identity).
- Password: the password for the identity.
- CA certificate: Select the CA certificate from the imported certificates.
- User certificate: Select the user certificate from the imported certificates.
- PAC certificate: When EAP-FAST is selected, also select the PAC certificate from the imported certificates. If the RADIUS server supports intra-band PAC deployment and deploy PAC for customers, there is no need to set a PAC certificate or password.
- PAC password: Enter the PAC password for the PAC certificate when EAP-FAST is selected. If the RADIUS server supports intra-band PAC deployment and deploy PAC for customers, there is no need to set a PAC certificate or password.

3.8 Troubleshooting

Sign	Possible causes	Recommended measures
The patient monitor cannot be connected to the AP and an X is displayed on the patient monitor's WiFi signal icon.	The nearby AP is not turned on.	Make sure the AP is turned on and it belongs to the VLAN for the patient monitor.
	The patient monitor is not turned on within the AP coverage area.	Go to the AP coverage area and turn on the patient monitor. Ensure that the signal strength displayed on the patient monitor is greater than –65dBm. Ensure the co-channel interference meets the requirements.
	The SSID and IP address acquisition mode and security mode are not properly configured on the patient monitor.	Refer to this manual to reconfigure this information.
	Patient monitor fault.	Check if another patient monitor can get online. If possible, restart the patient monitor and make sure the two patient monitors have the same configuration. If the patient monitor is still unable to get online then return it to Mindray for repair.
The patient monitor can access AP but is unable to be connected to the central monitoring system.	The patient monitor is not licensed to access the central monitoring system.	Patient monitor is allowed to access the central monitoring system.
	The patient monitor is unable to obtain any IP addresses, and the IP addresses in the IP address pool have all been taken.	Use other network devices to connect to the central monitoring system and check if the IP address can be obtained. If the problem still exists, contact IT department.
	A static IP address conflict has occurred.	Observe if a prompt indicating an IP address conflict is displayed on the patient monitor. If this prompt is displayed, ensure that all network devices have unique IP addresses.
	Network link trouble.	Confirm if the PC or mobile phone can ping the central monitoring system after being connected to the AP. If the problem still exists, contact IT department.
	The service port required for the patient monitor is not enabled on the hospital network.	Check if the service port required for the patient monitor is enabled on the hospital network. If not, enable related services (such as some UDP ports and multicast). If the problem still exists, contact IT department.
Intermittent disconnection occurs to a single	Move the patient monitor to the blind coverage area.	Check if the WiFi signal strength is greater than –65dBm in the location where disconnection occurs.

Sign	Possible causes	Recommended measures
patient monitor	Patient monitor fault.	Check if disconnection occurs easily to the patient monitor at the same location. If the problem cannot be resolved after restarting the patient monitor, return the patient monitor to Mindray for repair.
	A static IP address conflict has occurred.	Observe if a prompt indicating an IP address conflict is displayed on the patient monitor. Check if an IP address has been assigned to multiple devices.
Intermittent disconnection occurs to multiple patient monitors	APs in some areas are destroyed.	Make sure the AP has been turned on and works properly.
	There is strong interference in some areas.	Use the network survey tool to see if the interference is strong and remove significant sources of interference or adjust the WLAN deployment to meet Mindray requirements.
	Insufficient signal coverage in some areas.	Use the network survey tool to check signal coverage. If the signal coverage is insufficient in a certain area, adjust the AP position or increase APs.
Intermittent disconnection occurs to all patient monitors	Improper wired network configuration	Use a wired patient monitor to check wired network configuration Ensure that the WLAN bandwidth configured on the switch is sufficient with a 50% surplus
	Radio interference exists	Use the network survey tool to check if there is radio interference and remove obvious sources of interference or adjust the WLAN deployment to meet Mindray requirements.

FOR YOUR NOTES

4 Testing and Maintenance

4.1 Introduction

Service personnel need to inspect, maintain and test the monitor regularly to ensure that it can keep working stably for a long time. This chapter provides basic test methods for the monitor as well as recommended appropriate testing frequency and testing tools. Please maintain and test the monitor with proper testing tools and according to actual needs.

The testing and inspection methods provided in this chapter are mainly used to confirm if the performance of the monitor can meet the specifications. During the testing, if test results do not meet the requirements, it indicates that the monitor or a certain function module of the monitor goes wrong and needs to be repaired or replaced immediately. Any other questions, please contact our after-sales service department.

⚠ Attention

- **All tests can only be performed by qualified professional service personnel.**
- **Be careful when setting up and changing the contents in the maintenance and configuration menus, otherwise a data loss may be caused.**
- **Before the testing, service personnel need to ensure proper test tools and connection lines are used. Service personnel should be able to use these test tools proficiently.**

4.1.1 Test Device

See the following testing sections.

4.1.2 Test Report

After our service personnel have done the test, please record the details according to the maintenance and testing report at the last page of this chapter and return it to the after-sales service department of the company.

4.1.3 Preventive Maintenance

A list of items requiring preventive maintenance for this monitor is provided below. Regular maintenance is recommended to be conducted at least once every two years (once a year for the CO_2 module). (See the following sections for detailed testing procedures and contents)

Visual inspection

NIBP test

CO_2 testing and calibration

4.1.4 Recommended Frequency

<table>
<tr><th colspan="2">Inspection/maintenance items</th><th>Recommended frequency</th></tr>
<tr><td colspan="3">Preventive maintenance</td></tr>
<tr><td colspan="2">Visual inspection</td><td>Installation for the first time, or after each re-installation.</td></tr>
<tr><td rowspan="4">NIBP test</td><td>Pressure Test</td><td rowspan="7">1. When the user suspects that the measured value is not accurate.
2. After repairing or replacing the relevant module.
3. At least once every 2 years for the NIBP module, and once a year for the CO_2 module.</td></tr>
<tr><td>Leakage Test</td></tr>
<tr><td>Overpressure protection circuit test</td></tr>
<tr><td rowspan="3">Sidestream and microstream CO_2 test</td></tr>
<tr><td>Leakage Test</td></tr>
<tr><td>Performance test</td></tr>
<tr><td>Module calibration</td></tr>
<tr><td colspan="3">Performance test</td></tr>
<tr><td rowspan="2">ECG test</td><td>Performance test</td><td rowspan="15">1. When the user suspects that the measured value is not accurate.
2. After repairing or replacing the relevant module.
3. At least once every two years At least once a year for CO_2 module.</td></tr>
<tr><td>Module calibration</td></tr>
<tr><td colspan="2">Resp performance test</td></tr>
<tr><td colspan="2">Spo_2 test</td></tr>
<tr><td rowspan="2">NIBP test</td><td>Pressure Test</td></tr>
<tr><td>Leakage Test</td></tr>
<tr><td colspan="2">Temp test</td></tr>
<tr><td rowspan="2">IBP test</td><td>Performance test</td></tr>
<tr><td>Pressure calibration</td></tr>
<tr><td colspan="2">C.O. test</td></tr>
<tr><td colspan="2">Mainstream CO_2 test</td></tr>
<tr><td rowspan="3">Sidestream, microstream CO_2 test</td><td>Leakage Test</td></tr>
<tr><td>Performance test</td></tr>
<tr><td>Module calibration</td></tr>
<tr><td colspan="2">Nurse call test</td><td rowspan="2">When the user suspects that the nurse call or analog output function is not normal.</td></tr>
<tr><td colspan="2">Analog output test</td></tr>
<tr><td colspan="3">Electric safety test</td></tr>
<tr><td rowspan="4">Electric safety test</td><td>Housing leakage current test</td><td rowspan="4">1. After repairing or replacing the power module.
2. Or after the monitor falls off.
3. At least once every two years or as needed.</td></tr>
<tr><td>Earth leakage current</td></tr>
<tr><td>Patient leakage current</td></tr>
<tr><td>Patient auxiliary current</td></tr>
<tr><td colspan="3">Other tests</td></tr>
<tr><td colspan="2">Power On test</td><td>1. Installation for the first time, or after each re-installation.
2. After repairing or replacing the parts of the main unit.</td></tr>
</table>

Recorder check		After repairing or replacing the recorder.
Network printing check		1. Installation for the first time. 2. After repairing or replacing the printer.
Battery check	Function check	1. Installation for the first time. 2. After replacing the battery.
	Performance check	Every two months or when the battery running hours are significantly shortened.

4.2 Preventive Maintenance

4.2.1 Visual Inspection

Visual check mainly refers to a comprehensive visual check on the monitor appearance. If the monitor has no obvious physical damage, then it passes the visual check. The specific check items are as follows:

- Check if there's physical damage to the monitor housing, display and buttons.
- Whether the module suffers physical damage.
- Whether the power cord, bracket and module accessories suffer physical damage.
- Whether the external cable wears out, whether the connector pin is loose or twisted.
- Whether the monitor's peripheral interface is loose, whether the pins are twisted.
- Whether the safety label and nameplate are clearly legible.

4.2.2 NIBP Test

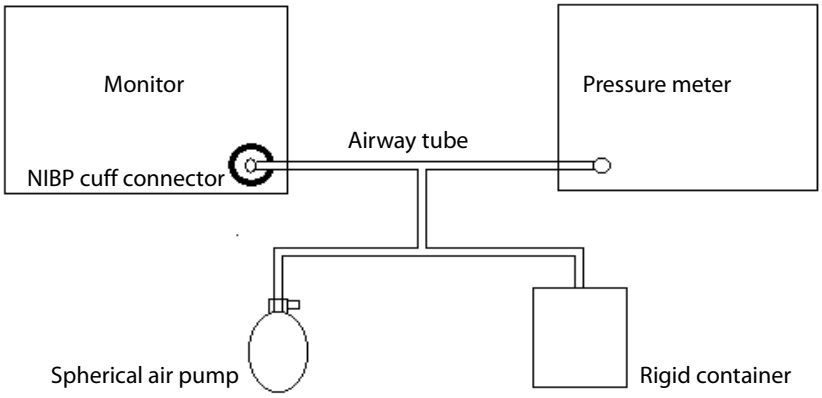
Pressure check

Test tools:

- T connector
- Airway tube
- Spherical air pump
- Rigid container: 500 ± 25 ml
- Standard pressure meter: has been calibrated with a precision of at least 1 mmHg

See the below for check steps:

1. Connect the monitor, standard pressure meter, spherical air pump and rigid container as shown below.



2. The standard pressure meter's reading should be zero before air inflation. If it is not zero, open the spherical air pump valve so that the airway leads to the atmosphere until the standard pressure meter reads zero, then close the valve.
3. Select [**Main Menu**] → [**Maintenance**] → enter password → [**Module**] → [**NIBP**] → [**NIBP Pressure Test**].
4. Check the readings of the standard pressure meter and the monitor, both of which should show a pressure value of 0mmHg.
5. Inflate the rigid container with a spherical air pump until the internal pressure reaches 50mmHg, then stop inflating and wait for 10s in order that the measurement value keeps stable.
6. Check the readings of the standard pressure meter and the monitor. The difference between the two should be within 3mmHg. If the difference is greater than 3mmHg, please contact service personnel.
7. Inflate the rigid container with a spherical air pump until the internal pressure reaches 200mmHg, then stop inflating and wait for 10s in order that the measurement value keeps stable. Repeat step 6.

Precautions

- **You can also use a blood pressure simulator instead of a spherical air pump and a standard pressure meter to form a test system.**
- **You can also replace the rigid container with cylinders and cuffs of a right size.**

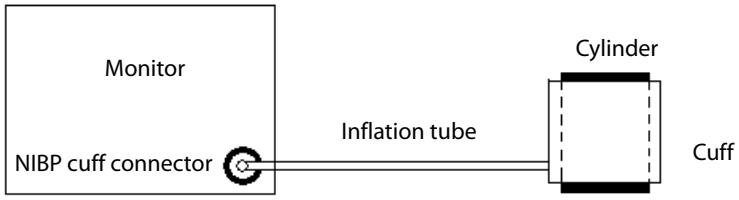
Leakage Test

Testing tools:

- Adult cuff
- Airway tube
- Cylinder

See the below for testing steps:

1. Set [**Patient Category**] to [**Adult**].
2. Connect well the cuff with the NIBP cuff connector of the monitor.
3. Wrap the cuff around a cylinder of a right size, as shown in the figure.



4. Select [**Main Menu**] → [**Maintenance**] → enter password → [**Module**] → [**NIBP**] → [**NIBP Leakage Test**], the NIBP parameter area will display [**Leakage Test...**].
5. After approximately 20 seconds, the system will automatically deflate which indicates the leakage test is completed.
6. If there is no prompt message in the NIBP parameter area, it means there is no air leakage in the system. If [**NIBP Air Leakage**] is displayed, it indicates that there may be an air leakage. At this time, the operator should check whether there is loose connection, whether the cuff and the inflation tube are damaged or leaked. When the connection is confirmed to be proper and there's no leakage in the cuff or the airway tube, then conduct a leakage test once again.

You can also perform a leakage test manually:

1. Perform steps 1 to 4 in the Pressure Calibration section.
2. Inflate the metal container with a spherical air pump until the internal pressure reaches 250mmHg, then stop inflating and wait for 5s in order that the measurement value keeps stable.
3. Record the current pressure and start timing using a timer. Record the pressure value after 60s.
4. The displayed pressure value after 60s minus the pressure value displayed at the beginning of the leakage test should not exceed 6mmHg.

Overpressure protection circuit test

Testing tools:

- T connector
- Airway tube
- Spherical air pump
- Rigid container: 500 ± 25 ml
- Standard pressure meter: has been calibrated with a precision of at least 1 mmHg

1. Perform steps 1 through 4 in the NIBP Pressure Check section.
2. Select [**Main Menu**] → [**Maintenance**] → enter password → [**Factory Maintenance**] → [**NIBP**] → [**Test**].
3. In [**Overpressure Protection Circuit Test**], select [**Adult/Child**] for [**Patient Category**], adjust the output pressure of the air pump to 320-330mmHg. After it keeps stable, select the [**Test**] button to

start **calibration**. When the **test** succeeds, the NIBP menu will display the prompt of [**Test** Successful]. If the pressure exceeds 320-330mmHg, [**Test** Failed] will be displayed.

4. In [**Overpressure Protection Circuit Test**], select [**Neo**] for [**Patient Category**] and adjust the air pump output pressure to 160-165mmHg. When the value keeps stable, select the [**Test**] button on the right side of the menu to start **Test**. When the **test** succeeds, the NIBP menu will display the prompt of [**Test Successful**]. If the pressure exceeds 160-165mmHg, [**Test Failed**] will be displayed.

4.2.3 Sidestream and Microstream CO_2 Testing and Calibration

Leakage Test

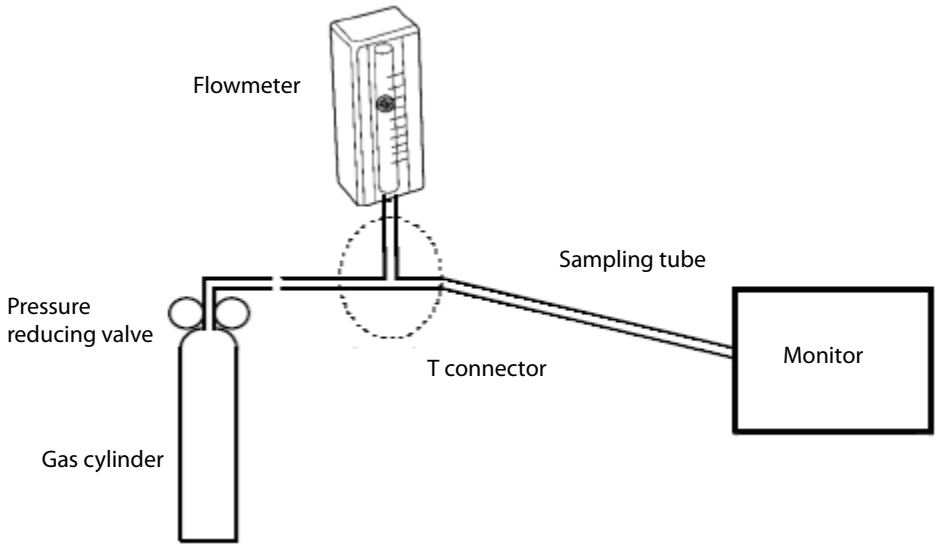
1. After the CO_2 preheating startup is completed, block the module or the water tank inlet hole completely by hand or other objects, the sidestream and microstream CO_2 modules will have different actions respectively:
   - Sidestream: Plug the sidestream CO_2 module into the module rack of the main unit. Wait for 1min., after the module completes preheating startup, block the module air intake with your fingers or other objects. The monitor will display the alarm message of [**CO_2 Airway Occluded**]. Keep blocking it for about 60s, check [**Maintenance**] → enter password → [**module**] → [**CO_2**] → [**CO_2 Module Calibration**], check that the current flow rate of the module is <10ml/min, and the alarm message continues, then it proves that the module has no air leakage. If the alarm message of [**CO_2 Airway Occluded**] disappears or the current flow rate is ≥10ml/min, it indicates that there is air leakage.
   - Microstream: Keep blocking the module air intake for 3s, the screen displays the alarm message of [**CO_2 Purging**]; continue to keep blocking it for about 30s, the alarm message of [**CO_2 Airway Occluded**] is displayed, then it proves that the module has no air leakage.

Precision test

Test tools:

- A steel cylinder containing 6 ± 0.05% CO_2 and a balance gas of N_2.
- Steel cylinder with O_2 gas (its concentration >40%) and a balance gas of N_2 (for sidestream CO_2 module with oxygen module)
- T connector
- Airway tube
- Flowmeter

1. Insert the module into the module rack.
2. After the CO_2 preheating startup is completed, check the airway and conduct leakage test to ensure that there is leakage.
3. Go to [**Maintenance**] → [**Module**] → [**CO_2**] → [**CO_2 Module Calibration**].
4. Connect the test system as shown below.



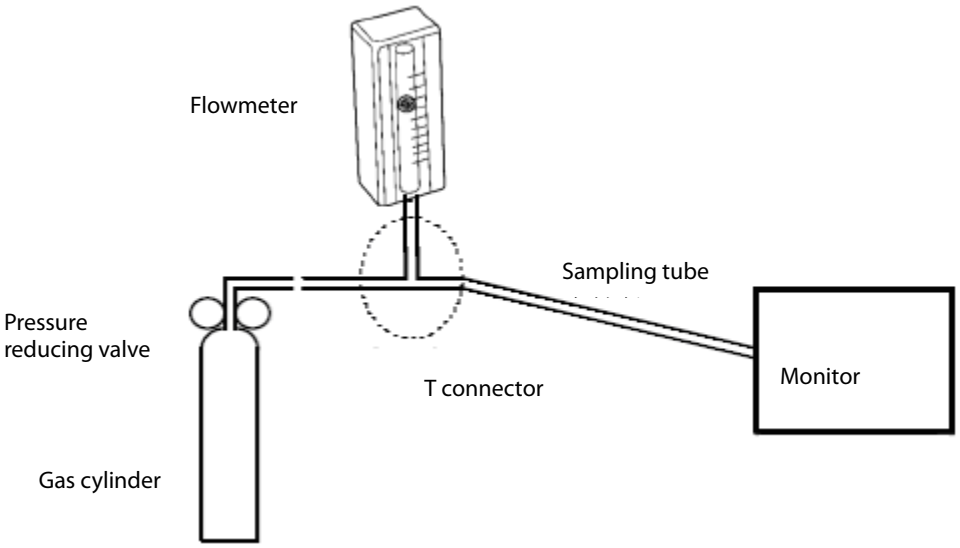
5. Open and adjust the pressure reducing valve switch until the flow rate indicated by the flowmeter is 10~50mL/min and it keeps stable.
6. Check and ensure that the real-time concentration of CO_2 displayed in the calibration menu is 6 ± 0.2% (45 ± 2mmHg for microstream CO_2).

Module calibration

Test tools:

- A steel cylinder containing 6 ± 0.05% CO_2 and a balance gas of N_2
- T connector
- Airway tube
- Flowmeter

1. Ensure that the sidestream CO_2 module or the microstream CO_2 module has completed preheating or startup.
2. Check the airway and conduct leakage test to ensure there is no leakage.
3. Open the [**CO_2 Calibration**] menu: select [**Main Menu**] → [**Maintenance**] → enter the user maintenance password → [**Module**] → [**CO_2**].
4. Select [**Zero**] in the [**CO_2**] menu.
5. After it is successfully set to zero, connect it as shown below.



6. Open and adjust the pressure reducing valve switch until the flow rate indicated by the flowmeter is 10~50mL/min and it keeps stable.
7. Enter 6% (CO_2 concentration value) in the [**CO_2%**] text box of the [**CO_2 Calibration**] menu.
8. The current measured CO_2 concentration will be displayed in the [**CO_2 Calibration**] menu. Wait until the measured CO_2 concentration keeps stable, select [**Calibration**] to calibrate the CO_2 module.

After the calibration is successful, the [**Calibration Completed**] message will be displayed on the [**CO_2 Calibration**] menu; if the calibration fails, the [**Calibration Failed**] message will be displayed. In this case, please check if the calibration operation is correct and re-calibrate. If multiple calibrations fail, please return to the factory for repair.

4.3 Power On Test

The power-on test is conducted to confirm whether the monitor can be turned on and work properly. If the monitor can be started as follows, then it passes the power-on test. Specific steps:

1. Connect the monitor to an AC power. The AC power indicator lights up and the battery indicator light is on.
2. Press the power switch to turn on the monitor, the system will give a "beep" sound (indicating that the alarm sound passes the self-test); the red, yellow and green alarm lights light up respectively, and finally go out (indicating that the alarm lights pass the self-test)).
3. The startup screen disappears and enters the main interface of the system, and the normal startup is completed.

4.4 Module Performance Test

4.4.1 ECG Test

ECG performance test

Test tools:

- Patient simulator Medsim300B

1. Connect the patient simulator to the ECG parameter module with the ECG lead wire.
2. Set the simulators as follows: ECG sinus rhythm, HR = 60 bpm, amplitude is 1 mV.
3. Check and ensure that the ECG waveform display is normal and with no noise, and the HR value displayed on the monitor should not exceed 60 ± 1 bpm.
4. Disconnect each lead in turn, and observe that the screen displays the corresponding lead-off information.
5. Set the output pace signal of the simulator, set the [**Pace**] to [**Yes**] for the monitor, and confirm that the screen displays the pacing sign.

ECG calibration

Test tools:

- Vernier caliper

1. Set the [**Filter Mode**] of ECG parameters to be [**Diagnose**].
2. Select [**Main Menu**] → [**Maintenance**] → enter password → [**Module**].
3. Select [**Calibration**], square wave signal will appear on the screen, and the technical alarm area will display [**ECG is Calibrating**].
4. Compare the amplitude of the square wave with the scale, and the error range should be no more than 5%.
5. After completing the calibration, select [**Stop Calibration**].

When needed, you can also output the above wave and scale by the recorder and measure the accurate error.

4.4.2 Resp Test

Test tools:

- Patient simulator Medsim300B

1. Connect the simulator and monitor with a non anti-ESU cable and set the monitor's resp lead to II.

2. Simulator settings: set the resp lead to II; basic damping to 500 Ω; variable damping to 1 Ω; and resp rate to 20 rpm.
3. Check if the monitor displays the RESP waveform with no distortion and that the displayed Resp value must not exceed 20 ± 1 rpm.

4.4.3 SpO_2 Test

Test tools:

- None

1. Connect the adult SpO_2 sensor to the monitor SpO_2 interface, set the [**Patient Category**] of the monitor to [**Adult**], and set [**PR Source**] to SpO_2.
2. Measure the SpO_2 of your finger (assuming you are in a healthy state).
3. Check that the monitor displays the pleth waveform and PR value of blood oxygen, and the displayed saturation value range of blood oxygen should be between 95%-100%.
4. Remove the SpO_2 sensor from your finger and confirm that an alarm is given to indicate the SpO_2 sensor is off.

Confirmation of measurement accuracy:
The accuracy of the MPM SpO_2 module has been confirmed in human experiments by comparison with the reference values of arterial blood sample measured by a CO-oximeter. The measurements of pulse oximeter are statistically consistent, and it is expected that only about two-thirds of the measurements will be within the specified accuracy compared to the measurements of CO-oximeter.

Precautions

- **The simulator cannot be used to verify the accuracy of the oxygen saturation monitor or the SpO_2 sensor, and can only prove that the working state of the monitor is normal. The accuracy of the oxygen saturation monitor or SpO_2 sensor needs to be verified by clinical data.**

4.4.4 NIBP Test

See ***4.2.2 NIBP*** test.

4.4.5 Temp Test

Test tools:

- Resistance box (accuracy not less than 0.1Ω)

1. Use a wire to connect both ends of any individual temperature interface of the parameter module to both ends of the variable resistor box.
2. The resistance box is set to 1354.9 Ω (corresponding to a temperature value of 37°C),

3. Verify each temperature channel of the monitor, and ensure that the monitor's display value does not exceed 37 ± 0.1℃.

4.4.6 IBP Test

Performance test

Test tools:

- Patient simulator Medsim300B, MPS450 or other equivalent devices
- Adapter cable for IBP test (300B, P/N: 00-002199-00) (MPS450, P/N: 00-002198-00)

1. Connect the simulator to the monitor's IBP parameter module.
2. Set that the simulator outputs 0mmHg to each IBP channel.
3. Press the "Zero" button of IBP module to conduct zero calibration for the parameter module.
4. Set the static pressure of the monitor = 200mmHg.
5. The display value on the monitor should not exceed 200 ± 2mmHg
6. If the error exceeds ± 2mmHg, perform a pressure calibration for the IBP parameter module. If the IBP parameter module has been calibrated for pressure with a reusable IBP sensor connected, then connect the IBP sensor and check the pressure calibration results.
7. Set the simulator to output 120/80mmHg ART signal and 120/0mmHg LV signal to each IBP channel respectively, and check if the IBP waveform is displayed correctly.

Pressure calibration

Method 1:
Test tools:

- Patient simulator Medsim300B, MPS450 or other equivalent devices
- Adapter cable for IBP test (300B, P/N: 00-002199-00) (MPS450, P/N: 00-002198-00)

1. Connect the simulator to the monitor's IBP parameter module.
2. Set the simulator to zero pressure.
3. Press the "Zero" button of IBP module to conduct zero calibration for the parameter module.
4. Set the static pressure of the monitor = 200mmHg.
5. Select [**Main Menu**] → [**Maintenance**] → enter the user maintenance password → [**Module**] → [**IBP**] → [**Calibration**].

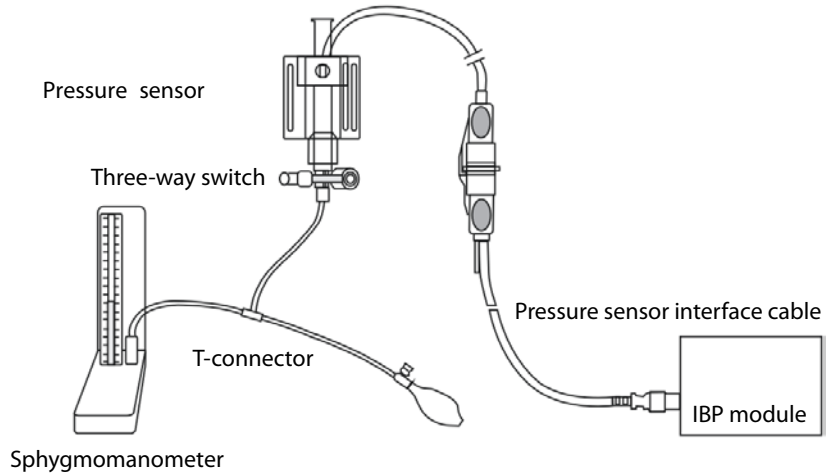
   In the [**IBP**] menu, set the calibration value of the target pressure to 200mmHg.
6. Select the [**Calibration**] button on the right side of the target channel and the monitor will begin calibrating.
7. When calibration completes, it will display [**Calibration Completed**]. If it cannot be calibrated, it will display corresponding prompt message.

Method 2:

Calibration tools:

- Pressure meter
- Spherical air pump
- Airway tube
- T connector

1. Connect the three-way switch to the sphygmomanometer and the spherical air pump using a T-connector, as shown below.
2. First perform zero calibration. After the calibration is completed, the three-way switch leads to the sphygmomanometer.



3. Select [**Main Menu**] → [**Maintenance**] → enter the user maintenance password → [**Module**] → [**IBP**] → [**Calibration**]. In the open interface, set the target pressure calibration value of the target channel. Input the range: 80 ~ 300mmHg.
4. Inflate with a spherical air pump to allow the pressure reading of the sphygmomanometer to get close to the pressure set in the menu.
5. Repeat the adjustment of the calibration pressure value in the menu and the pressure value of the sphygmomanometer until they are the same.
6. Select the [**Calibration**] button of the target channel and the defibrillation monitor will begin calibrating.
7. When calibration completes, it will display [**Calibration Completed**]. If it cannot be calibrated, it will display corresponding prompt message.

4.4.7 C.O. Test

Test tools:

- Patient simulator Medsim300B
- C.O. adapter box (for 300B)

1. Connect the simulator to the monitor C.O. parameter module using the main cable of C.O. accessory.
2. Set the simulator's blood temperature (TB) to 37 °C and ensure that the display value on the monitor does not exceed 37 ± 0.1 °C.
3. Set the [**Injection Temp Source**] to [**Manual**], adjust the [**Injection Temp Value**] (TI) until it displays 24 °C, select [**C.O. Measure**], open the C.O. measure window, and set [**Comp Const**] to 0.595.
4. Set the injection temperature of the C.O. simulator to 24 °C, and the cardiac output to 5 L/min. Press [**Start**] in the C.O. measure window to start C.O. measure, then within 3 to 10s, press the RUN button of the simulator.
5. The displayed C.O. measure result is 5 ± 0.25L/min.

4.4.8 Mainstream CO_2 Test

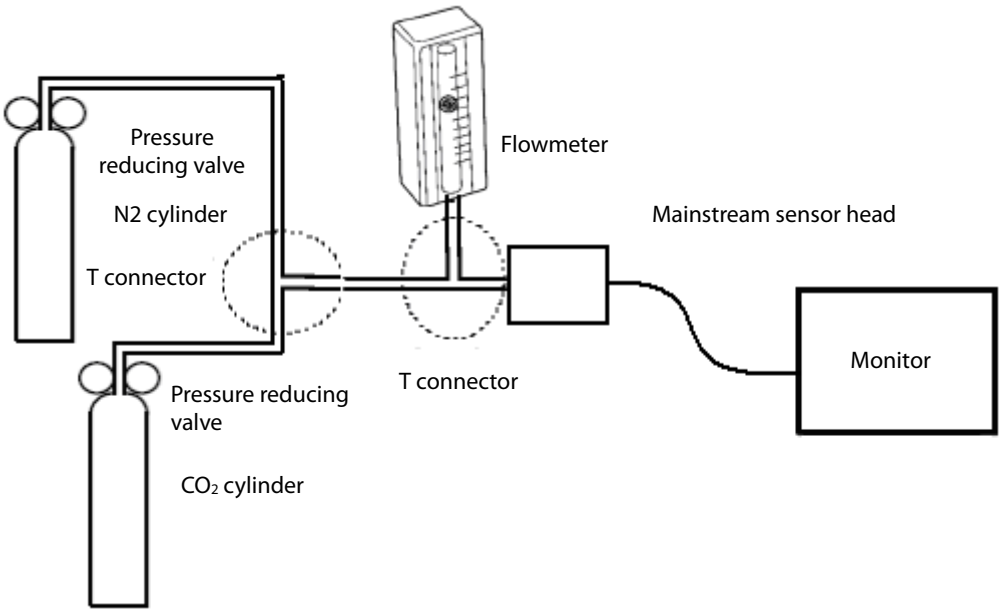
Precautions

- **Before performing the mainstream CO_2 test, check and ensure that the atmospheric pressure setting in the [CO_2 Module Maintenance] of [Maintenance] is consistent with the local atmospheric pressure value.**

Test tools:

- A steel cylinder containing 6 ± 0.05% CO_2 and a balance gas of N_2.
- Steel cylinder with 100% N_2 gas
- T connector
- Airway tube
- Flowmeter

1. Insert the module into module rack and connect a sensor.
2. When the CO_2 preheating startup completes, go to the [**CO_2 Setup**] menu, click [**Zero**] to conduct zero calibration for the CO_2 module. If the zero calibration fails, the screen prompts [**Zero Failed**]; if the zero calibration succeeds, the baseline of the CO_2 waveform on the screen returns to the zero position.
3. Go to [**CO_2 Setup**] menu and set [**Apnea Delay**] to 10s.
4. Place the sensor in front of the mouth and breathe, so that the CO_2 waveform is generated on the screen, then place the sensor in the air and ensure that the monitor generates an alarm message [**CO_2 Apnea**].
5. Connect the test system as shown below.



6. Open the pressure reducing valve of the N2 cylinder and the CO_2 cylinder respectively, and ensure that only one cylinder is connected to the T-connector at the same time.
7. Adjust the pressure reducing valve switch respectively so that the flow rate indicated by the flow meter is 2~5L/min and it keeps stable.
8. Switch the cylinder connected to the T-connector at an interval of 6s~10s and ensure that the CO_2 display value should be 45 ± 2mmHg.

4.4.9 Sidestream and Microstream CO_2 Testing and Calibration

See ***4.2.3 Sidestream*** and microstream CO_2 testing and calibration.

4.5 Nurse Call Test

Test tools:

- Multimeter

1. Connect the nurse call line to the nurse call output port of the monitor.
2. Set the monitor to [**Demo**] status, select [**Main Menu**] → [**Maintenance**] → enter the user maintenance password → [**Alarm**] → [Nurse Call].
3. In the [**Nurse Call**] menu, select [**Alarm Priority**] and [**Alarm Category**], and set [**Trigger Mode**] to [**Normally Open**].
4. In the [**Nurse Call**] menu, set [**Signal Type**] to [**Pulse**]. Set the monitor to generate an alarm, check the pulse with a pulse width of 1s when there is an alarm, and the multimeter measures the conducting state.

5. In the [**Nurse Call**] menu, set [**Signal Type**] to [**Continuous**]. Set the monitor to generate an alarm, check the continuous high level outputted when there is an alarm, and the multimeter can measure the conducting state.

4.6 Analog Output Test

Test tools:

- Patient simulator
- Oscilloscope

1. Connect the patient simulator to the monitor via an ECG line or IBP measurement line, and connect the oscilloscope to the analog output port.
2. Verify that the waveform displayed on the oscilloscope matches that displayed on the monitor screen.

4.7 Electric Safety Test

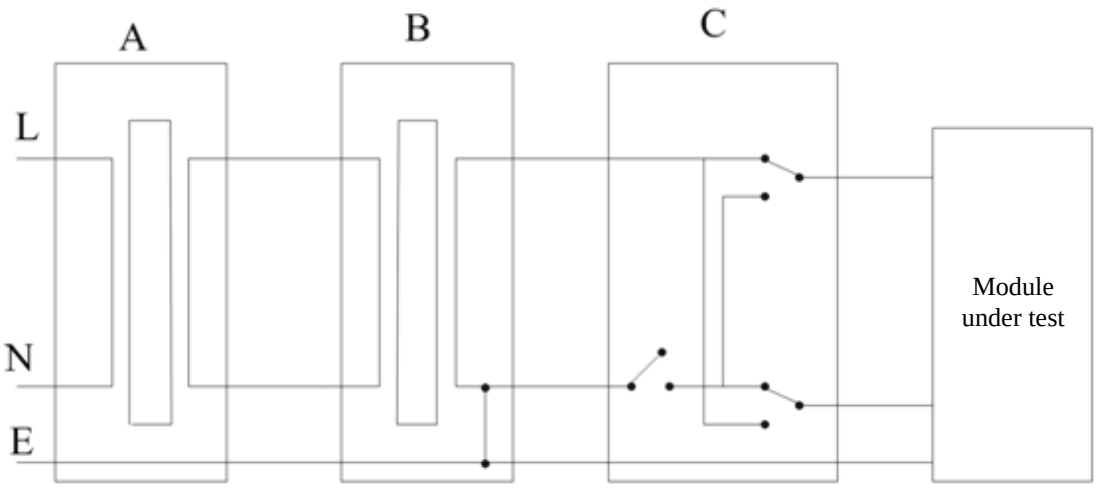
⚠Warning

- **Electrical safety test is used to test the electrical safety of the monitor under test. It's used to detect abnormal electrical hazards. If these hazards are not detected in time, it may cause harm to patients or operators.**
- **Electrical safety tests can be carried out using test equipment such as commercially available safety analyzers. Service personnel are required to ensure the applicability, functional integrity and safety of the test equipment, and familiarize with the use of it.**
- **Electrical safety test should comply with the following standards: EN 60601-1 and UL60601.**
- **If it's stipulated otherwise by local laws and regulations, please carry out relevant electrical safety tests in accordance with applicable regulations.**
- **In the patient area, all the equipment that uses AC power and is connected to medical equipment must comply with IEC 60601-1 and must receive electrical safety test at the intervals as required by the monitor.**

Electrical safety test is used to detect electrical hazards that may cause harm to patients, operators and service personnel. Perform electrical safety tests under normal conditions (including temperature, humidity and atmospheric pressure).

The electrical safety test given in this chapter uses the 601 safety analyzer as an example. The safety analyzers used may vary by different regions. Please ensure the applicability of your electrical safety test plan.

See the figure below for equipment connection.



A: AC power (programmable power supply, regulate frequency)

B: Isolation figure for leakage current test on tooling

C: Safety tester

Test tools:

- Safety analyzer
- Isolation transformer

4.7.1 Housing Leakage Current Test

1. Connect the 601 safety analyzer to a 264 VAC, 60 Hz power supply.
2. Connect the equipment under test to the auxiliary power output jack of the 601 safety analyzer via a power line.
3. Connect one end of the red test lead to the "Red input terminal" of the safety analyzer and press the other end against the metal foil that is in close contact with the housing surface of the equipment under test.
4. Power on the 601 safety analyzer and press "5-Enclosure leakage" on the panel of the 601 safety analyzer to enter the interface for housing leakage current test.
5. Normally the leakage current of the housing is not more than 100 μA, and not more than 300 μA in a single fault condition.

4.7.2 Earth Leakage Current Test

1. Connect the 601 safety analyzer to a 264 VAC, 60 Hz power supply.
2. Connect the application part of the equipment under test to the RA side of the safety analyzer.
3. Connect the equipment under test to the auxiliary power output jack of the 601 safety analyzer via a power line.

4. Power on the 601 safety analyzer and press "4-Earth leakage" on the panel of the 601 safety analyzer to enter the interface for earth leakage current test.
5. Normally the earth leakage current is not more than 300 μA, and not more than 1000 μA in a single fault condition.

4.7.3 Patient Leakage Current Test

1. Connect the 601 safety analyzer to a 264 VAC, 60 Hz power supply.
2. Connect the application part of the equipment under test to the RA side of the safety analyzer.
3. Connect the equipment under test to the auxiliary power output jack of the 601 safety analyzer via a power line.
4. Power on the 601 safety analyzer and press "6-Patient leakage" on the panel of the 601 safety analyzer.
5. Press the "APPLIED PART" button continuously to select AC and DC measurements. When it's DC, "DC" is displayed behind the limit value.
6. Normally the patient leakage current is not more than 10 μA, and not more than 50 μA in a single fault condition.

4.7.4 Patient Auxiliary Current Test

1. Connect the 601 safety analyzer to a 264 VAC, 60 Hz power supply.
2. Connect the equipment under test to the auxiliary power output jack of the 601 safety analyzer via a power line.
3. Connect the ECG line of the equipment under test to the RA end of the safety analyzer.
4. Power on the 601 safety analyzer and press the "8-Patient Auxiliary Current Test" on the panel of the 601 safety analyzer to enter the interface for patient auxiliary current test.
5. Press the "APPLIED PART" button continuously to select AC and DC measurements. When it's DC, "DC" is displayed behind the limit value.
6. Normally the patient auxiliary current is not more than 10 μA, and not more than 50 μA in a single fault condition.

4.8 Recorder Check

Test tools:

- None

1. Print the ECG waveform, the recorder should be able to print normally with sound clarity and consistency.
2. Setup should ensure that relevant prompts should be displayed if it is out of paper or the buckle cambers or other malfunctions, and it should work normally after recovery.

3. Perform alarm printing for each parameter, turn on the alarm recording switch of each parameter, set different alarm limits, and ensure to conduct printing for each parameter alarm.

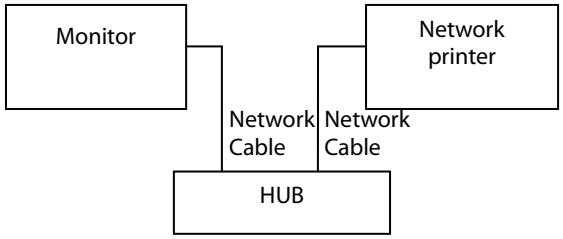
4.9 Network Printing Check

Test tools:

- Hub and network cable

4.9.1 Equipment Connection and Setup

1 Equipment connection: Connect the monitor and network printer to the hub via a common network cable, as shown in the following figure:



2 IP setup: Go to the "Main Menu" interface, select [**Main Menu**] → [**Maintenance**] → enter the user maintenance password, select [**Network Setup**] in the maintenance interface, and set the IP address of the monitor to be in the same network segment with the IP address of the network printer (See the instructions for the printer).

4.9.2 Printing Function Test

1 Enter demo mode of the monitor.

2 Go to the "Main Menu" interface, select [**Interface Setup**] → [**Interface Layout**], and select "ECG Full-Screen 7 Lead Interface".

3 Go to the "Main Menu" interface, select [**Normal Report**] → [**ECG Report**], select normal report, click "Print", and the network printer should print out the ECG report.

4.10 Battery Check

Test tools:

- None

Function check

1. Check that the monitor works properly when powered by AC.
2. Remove the AC power line and check that the monitor continues to operate properly.

Performance check

Please refer to the relevant contents in the **battery** section of the operator's manual to check that the battery power supply time meets the specifications.

4.11 Charging Dock Check

Test tools:

- Multimeter

Function check

1. Disconnect the charging dock from the monitor and connect the charging dock to the DC power supply (12V-28) on the ambulance.
2. When the charging dock is powered on, the green power indicator lights are lit.
3. Use a multimeter to measure the output port voltage of the transmission dock. The voltage should be (15V +5%).
4. Connect the monitor and check if it can be turned on properly.

4.12 Factory Maintenance

4.12.1 Enter Factory Maintenance

Select [**Main Menu**] hot key → turn to the page 3 → select [**Maintenance**] from the [**System**] column → enter the factory maintenance password → select [**Ok**], then select factory maintenance.

4.12.2 Monitor Iinformation (Exporting Log)

Before inserting the USB flash drive, confirm that its format is FAT32, and then insert it into the USB port of the monitor's main unit (Note: Not the USB port of the iView's main unit!) ,

Open the [**Monitor Information**] menu, you can see the information about the monitor's main unit, such as: CPU temperature, Wifi signal strength, hard disk capacity and so on.

At this point, you can export all the monitor's log information by clicking the "Export Log" button in the bottom left corner of the window.

4.12.3 Production Test

Open the [**Production Test**] menu and you can perform basic function tests related to the monitor's hardware interface.

Production test includes auto test and single test.

- Auto test: After selecting [**Start Auto Test**], the system will automatically completes all tests in order.
- Single test: Select one for a single test.

4.12.4 Setup

Open the [**Setup**] menu and you can do ECG alarm settings and other configurations.

4.12.5 Debugging

Open the [**Debug**] menu and you can make settings related to debugging tests.

4.12.6 Power Information

Open the [**Power Info**] menu and you can check the power status of the monitor.

4.12.7 Clinical Data

Open the [**Clinical Data**] menu and you can do settings related to clinical data collection.

When the Clinical Data Location is selected as "Local", the clinical data is stored in the monitor. You can export the data to the USB flash drive by the same way as exporting the log.

When the Clinical Data Location is selected as "Udisk", the clinical data is directly stored in the U disk.

4.12.8 Sending Clinical Data

Open the Send Clinical Data menu and you can select the clinical data you need to send.

4.12.9 Software Version

Open the maintenance menu and select the [Version] menu, you can view all the software versions in the system that can be viewed.

Maintenance test report

(For detailed test steps and contents, see the above section)

Client name		
Client address		
Maintenance people		
Maintenance company name		
Name of device under test		
Model of device under test		
Serial No. of device under test		
Hardware version		
Software Version		
Test device	Model/No.	Validity of calibration

Test Item		Test result	Test result (Pass/Fail)
Visual inspection			
There should be no physical damage to the monitor housing, display, buttons, SMR, modules, power cords, brackets and module accessories			
The external connection cable should be free of wear and the connector pins should have no looseness or distortion			
The monitor's peripheral interface should have no looseness or distorted pins			
Safety labels and nameplates should be clearly legible			
Power On test			
It passes power-on test, the power indication and alarm system work normally, and the monitor starts normally.			
Performance test			
ECG performance test			
The ECG waveform is normal and noise-free, and the HR value displayed on the monitor must not exceed 60 ± 1 bpm			
The "ECG Lead Off" alarm works properly.			
When the pacing is turned on, the pacing signal can be detected and the pacing mark is displayed.			
The difference between ECG calibrated waveform amplitude and scale amplitude should not exceed 5%			
RESP test			
The monitor shows that the RESP waveform is not distorted, and the displayed Resp value must not exceed 20 ± 1 rpm.			
SpO_2 test			
Connect healthy people's finger to test, the monitor displays the blood oxygen pleth waveform and the PR value, and the displayed SpO_2 value range should be 95% to 100%.			
SpO_2 sensor off alarm function is normal			
NIBP test			
For NIBP pressure test, 0, 50 and 200mmHg test difference does not exceed ± 3mmHg			
There is no gas leakage in NIBP, or the manual leakage test result does not exceed 6mmHg/min.			
Temp test			
The display value of each temperature channel of the monitor does			

not exceed 37 ± 0.1℃		
IBP test		
Static pressure display value of each IBP channel does not exceed 200 ± 2mmHg		
The ART and LV waveforms of each IBP channel are displayed correctly		
C.O. test		
Monitor's TB display value does not exceed 37 ± 0.1℃		
The displayed C.O. measurement result is 5 ± 0.25L/min.		
Mainstream CO_2 test		
The mainstream CO_2 zero calibration is successful, and the baseline of the CO_2 waveform returns to the zero position on the screen.		
The CO_2 Apnea alarm is normal.		
The CO_2 display value should be 45 ± 2mmHg		
Sidestream CO_2 test		
After blocking the air inlet of the water tank, the flow rate of the sidestream CO_2 is <10ml/min, and it alarms CO_2 airway is blocked, and there is no air leakage		
CO_2 display value should be 6 ± 0.2%		
Microstream CO_2 test		
After the microstream CO_2 is blocked for about 30s, it alarms CO_2sampling airway is blocked, and the module has no air leakage		
The CO_2 display value should be 45 ± 2mmHg		
Nurse call test		
Nurse call cable conducts when the monitor alarms		
Analog output test		
The waveform displayed by the oscilloscope should be consistent with that displayed on the monitor's screen.		
Electric safety test		
Normally the housing leakage current is not more than 100 μA, and not more than 300 μA in a single fault condition.		
Normally the earth leakage current is not more than 300 μA, and not more than 1000 μA in a single fault condition.		
Normally the patient leakage current is not more than 10 μA, and not more than 50 μA in a single fault condition.		
Normally the patient auxiliary current is not more than 10 μA, and not more than 50 μA in a single fault condition.		
Recorder check		
Can print ECG waveforms normally with sound consistency and clarity		
Setup should ensure that relevant prompts should be displayed if it is out of paper or the buckle cambers or other malfunctions, and it should work normally after recovery		

The alarm recording function of each parameter is normal.		
Network printing check		
4 The network printer can print an ECG report properly		
Battery check		
Batteries support monitor to continue to operate normally when AC power is accidentally disconnected		
Battery power supply time meets product's specifications		

Test conclusion:

Pass or not: (Yes No)

Sign by the tester: Test Date:

FOR YOUR NOTES

5 Troubleshooting

5.1 Introduction

This chapter lists the problems that may occur during the use of the monitor and recommended measures. Check the monitor as per the table given in this chapter to identify and resolve problems. For more information on troubleshooting, please contact Mindray after-sales service department.

5.2 Component Replacement

The PCB, main parts and components of the monitor can be replaced. Once PCB failure is identified, replace the PCB as per the instructions given in the Repair and Disassembly section. Then confirm that the monitor can work properly and passes all performance tests. For information on replaceable parts, please refer to ***8 Parts***.

5.3 Checkup before Starting the Monitor

In addition, it is necessary to check whether the appearance is damaged before starting the machine. In particular, if the touch screen of the screen assembly is damaged, do not use it.

5.4 Software Version Check

In some troubleshooting, it may involve the compatibility of software version. In this case, you need to know the monitor configuration and software version. For details about version compatibility, please contact our after-sales service department. Please follow the steps below to check software version:

Select **[Main Menu]** → turn to the third page → select **[Maintenance >>]** from the **[System >>]** column → enter the factory maintenance password → **[Version >>]**. In the pop-up menu, you can view the information about the system software version.

5.5 Technical Alarm Messages

This section lists technical alarms, their default priority, indication on alarm reset, and the actions that can be taken when an alarm occurs.

Technical alarms give different alarm indicators when the alarm system is reset. In this section we classify the technical alarms into three categories for easy clarification:

- A: technical alarms are cleared. The monitor gives no alarm indications.

- B: technical alarms are changed to the prompt messages.
- C: the alarm is silenced and a √ appears before the alarm message, indicating that the alarm is acknowledged.

In the following tables we will use A, B, and C to refer to the indications on alarm reset.

5.5.1 General Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
XX Module Error	High	C	XX module does not work properly. Replug the module, if the alarm persists, contact your service personnel.

Note: XX represents a measurement or parameter label, such as HR, RR, SpO_2, $EtCO_2$, and so on.

5.5.2 ECG Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
ECG Noisy	Low/Prompt	A	The ECG signal is noisy. Check for any possible sources of signal noise around the cable and electrode, and check the patient for excessive motion.
ECG Amplitude Too Small	Low	C	The ECG amplitude does not reach the detected threshold. Check for any possible source of interference around the cable and electrode.
ECG Lead Off	High, Med, or Low, configurable	B	The electrode has become detached from the patient or the lead wire has become disconnected from the adapter cable. Check the connections of the electrodes and leadwires.
ECG XX Lead Off	High, Med, or Low, configurable	B	The electrode has become detached from the patient or the lead wire has become disconnected from the adapter cable. Check the connections of the electrodes and leadwires.
ECG Signal Invalid	Low	A	Patient skin impedance is too high. Check ECG electrode application.
ECG Learning	Prompt	/	ECG learning is manually or automatically triggered.
Cannot Analyze QT	Prompt	/	/
D12L not available	Prompt	C	The current Va and Vb combination does not support D12L. Choose an available Va and Vb combination. For more information, see *9.5 Using 6-lead Placement to Derive 12-lead ECG*

Alarm message	Default priority	Indication on alarm reset	Cause and solution
			(D12L).

Note: XX represents ECG lead name, for example RL, LL, V, Va, Vb, and so on.

5.5.3 Resp Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
Resp Interference	Prompt	/	The respiration circuit is disturbed. Check for any possible sources of signal noise.
Electrode Poor Contact	Prompt	/	Check the electrode application. Reposition or replace the electrodes if necessary.

5.5.4 SpO_2 Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
SpO2 Sensor Off	Adjustable	B	The SpO_2 sensor has become detached from the patient or the module. Check the sensor connection. If the alarm persists, replace the sensor.
SpO2 No Sensor	Low	A	The SpO_2 extension cable is detached from the SpO_2 module, or the SpO_2 sensor is detached from the SpO_2 extension cable. Check the SpO_2 cable and the sensor connection. If the alarm persists, replace the sensor.
SpO2 Excess Light	Low	C	Ambient light is too strong. Move the sensor to a place with lower level of ambient light or cover the sensor to minimize the ambient light.
SpO_2 No Pulse	Low	C	The SpO_2 sensor failed to obtain pulse signal. Check the patient's condition and replace the sensor application site. If the alarm persists, replace the sensor.
SpO_2 Sensor Incompatible	Low	C	Incompatible or an unspecified SpO_2 sensor is used. Use specified sensors.
SpO_2 Low Signal Quality	Low	C	1. Check the sensor and sensor position. 2. Make sure the patient is not shivering or moving. 3. The patient's pulse may be too low to be measured.

Alarm message	Default priority	Indication on alarm reset	Cause and solution
SpO_2 Interference	Low	C	The SpO_2 signal has been interfered. Check for any possible sources of signal noise and check the patient for excessive motion.
SpO_2 Sensor Error	Low	C	Replace the sensor and measure again.
SpO_2 Searching Pulse	Prompt	/	SpO_2 is searching for pulse.
SpO_2 Low Perfusion	Prompt	/	The SpO_2 sensor is not properly placed or the patient's perfusion index is too low. 1. Check the sensor and sensor position. 2. Reposition the sensor if necessary.

5.5.5 Temp Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
T XX Sensor Off	Low	A	Check the sensor connection and reconnect the sensor.

Note: XX represents a temperature site, for example skin, core, axil, T1, and so on.

5.5.6 NIBP Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
NIBP Cuff Loose	Low	A	There is a leak in the cuff or air tubing. Use a cuff of correct type based on the patient size. Apply the cuff and connect the air tubing as instructed in the manual.
NIBP Cuff or Airway Leak	Low	A	Check the NIBP cuff and pump for leakages.
NIBP Airway Error	Low	A	The air tubing may be occluded. Check the air tubing for an occlusion or kinking. If the alarm persists, contact your service personnel.
NIBP Weak Signal	Low	A	The patient's pulse is weak or the cuff is loose. Check the patient's condition and replace the cuff application site.
NIBP Overrange	Low	A	The measured NIBP value exceeds the module measurement range. Check the patient's condition.
NIBP Excessive Motion	Low	A	Check the patient's condition and reduce patient motion.
NIBP Cuff Overpressure	Low	A	The NIBP airway may be occluded. Check the airway and measure again. If the alarm persists, contact your service personnel.

NIBP Timeout	Low	A	The measurement time exceeds 120 seconds in the adult or pediatric mode, or exceeds 90 seconds in the neonatal mode, and the BP value cannot be obtained. Check the patient's condition and NIBP connections, or replace the cuff and measure again.
NIBP Cuff and Patient Mismatch	Low	A	The cuff type mismatches the patient category. Verify the patient category or replace the cuff if necessary. If patient catergory is correct, check that the tubing is not bent and the airway is not occluded.
NIBP Airway Leak	Low	A	Airway leakage is found during the NIBP leakage test. Check the NIBP cuff and pump for leakages.

5.5.7 IBP Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
XX Sensor Error	Med	C	The IBP sensor fails. Replace the sensor.
XX No Sensor	High, Med, or Low, configurable	A	The IBP patient cable and/or corresponding IBP sensor is not connected or detached. Check the cable and sensor connection.
XX No Pulse	Low	A	The catheter may be occluded. Please flush the catheter.
XX Disconnected	High	C	The liquid way is disconnected from the patient, or the three-way valve is open to the air. Check the connection of the liquid way, or check the valve is open to the patient. If the alarm persists, contact your service personnel.

Note: XX represents an IBP label, for example PA, CVP, FAP, P1, and so on.

5.5.8 C.O. Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
TB Sensor Off	Low	A	Check the sensor connection and reconnect the sensor.
T1 Sensor Off	Low	A	Check the sensor connection and reconnect the sensor.

5.5.9 CO_2 Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
CO_2 Module High Temp	Low	C	Ambient temperature is too high or there is a module failure. 1. Lower the operating temperature. 2. Replug the module. 3. If the alarm persists, the CO_2 module may fail, contact your service personnel.
CO_2 Module Low Temp	Low	C	Ambient temperature is too low or there is a module failure. 1. Raise the operating temperature. 2. Replug the module. 3. If the alarm persists, the CO_2 module may fail, contact your service personnel.
CO_2 Zero Failed	Low	C	For mainstream CO_2 module, check the connections between the adapter and CO_2 transducer. Wait till the sensor's temperature becomes stabilized, and then perform a zero calibration again. For sidestream CO_2 module, replug the module. If the alarm persists, contact your service personnel.
CO_2 No Watertrap	Low	B	Check the watertrap connections.
CO_2 High Airway Pressure	Low	C	1. Check the airway pressure settings of the ventilator/anesthesia machine. 2. Disconnect the module from the ventilator/ anesthesia machine. 3. Replug the module. 4. If the alarm persists, contact your service personnel.

Alarm message	Default priority	Indication on alarm reset	Cause and solution
CO_2 Low Airway Pressure	Low	C	1. Check the airway pressure settings of the ventilator/anesthesia machine. 2. Disconnect the module from the ventilator/ anesthesia machine. 3. Replug the module. 4. If the alarm persists, contact your service personnel.
CO_2 High Barometric	Low	C	The ambient pressure exceeds the operating pressure range or CO_2 module fails. 1. Make sure that the ambient pressure meets the specifications, and check for sources that affect the ambient pressure. 2. Replug the module. 3. If the alarm persists, contact your service personnel.
CO_2 Low Barometric	Low	C	The ambient pressure exceeds the operating pressure range or CO_2 module fails. 1. Make sure that the ambient pressure meets the specifications, and check for sources that affect the ambient pressure. 2. Replug the module. 3. If the alarm persists, contact your service personnel.
CO_2 Airway Occluded	Low	C	1. Check if the sample line is kinked or occluded. 2. Replace the sample line. 3. Replug the module. 4. If the alarm persists, contact your service personnel.
CO_2 No Filterline	Low	A	Make sure that the filterline is connected.
CO_2 Calibration Required	Low	C	Perform a calibration.
CO_2 Airway Error	Low	C	1. Check if the sample line is kinked or occluded. 2. Replace the sample line. 3. Replug the module. 4. If the alarm persists, contact your service personnel.
CO_2 Adapter Error	Low	A	Check, clean or replace the airway adapter. Perform a zero calibration.
CO_2 No Sensor	Low	A	Make sure that the CO_2 transducer is connected.

Alarm message	Default priority	Indication on alarm reset	Cause and solution
CO_2: Change Watertrap	Low	C	Replace the watertrap.
CO_2 Watertrap and Patient Mismatch	Low	C	Check the patient category and use a correct watertrap.
CO_2: Change O_2 Cell	Low	C	The oxygen sesnor is depleted or fails. Replace the oxygen sensor.

5.5.10 AG Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
AG No Watertrap	Low	B	Check the connections of the watertrap and re- connect it.
AG: Change Watertrap	Low	C	Replace the watertrap.
AG Watertrap and Patient Mismatch	Low	C	Check the patient category and use a correct watertrap.
AG Zero Failed	Low	C	There is external electromagnetic interference, airway occlusion or module failure. 1. Check for external inference sources. 2. Check for "AG Airway Occluded" alarm message. Remove the occlusion. 3. If the alarm persists, contact your service personnel.
Anesthetic Mixture	Low	C	Anesthetic mixture is detected.
AG Airway Occluded	Low	C	1. Check if the sample line is occluded. 2. Check the sample line. 3. Replug the module. 4. If the alarm persists, contact your service personnel.

5.5.11 BIS Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
BIS Sensor Off	Low	A	Check and reconnect the BIS sensor. If the alarm persists, replace the sensor.
BIS Electrode XX Off	Low	A	Check the electrode connection, and re-attach the electrodes if necessary.
BIS Electrode XX Poor Contact	Low	A	Enter the **Sensor Check** menu, and check the connections of the sensor and electrodes.
BISx Error	High	C	Replug the module. If the alarm persists, contact your service personnel.

Alarm message	Default priority	Indication on alarm reset	Cause and solution
BIS No Sensor	Low	A	BIS sensor is not properly connected, BIS cable fails, BISx or BISx4 fails. 1. Check the BIS sensor connection. 2. Replug the BIS module. 3. Replace the BIS cable. 4. Replace BISx or BISx4.
BIS Sensor Too Many Uses	Low	A	Replace the sensor.
BIS Sensor Old	Low	A	Replace the sensor.
BIS XX Signal Quality Too Low	Low	A	SQI < 15 1. Check the patient's condition. 2. Check the sensor position, and its contact with the patient's skin. 3. Check that BISx or BISx4 is away from the electrically radiating equipment.
BIS XX Low Signal Quality	Low	A	SQI < 15 1. Check the patient's condition. 2. Check the sensor position, and its contact with the patient's skin. 3. Check that BISx or BISx4 is away from the electrically radiating equipment.
BIS Wrong Sensor Type	Low	A	Check or replace the sensor.
BIS Sensor Error	Low	C	Replace the sensor.
Disconnect/Reconnect BIS	Low	A	Replug the BIS Module.

Note: XX represents BIS label, for example G, C, LE, LT, RL-RA, L-R, F-R, 1, 2, and so on.

5.5.12 Power Supply Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
Low Battery	Med	C	Connect the monitor to the external power supply and allow the batteries to charge.
Critically Low Battery	High	C	Connect the monitor to the external power supply and allow the batteries to charge.
Power Board Comm Error	High	C	Restart the monitor. If the alarm persists, contact your service personnel.
Battery Error	High	C	The battery may fail. Contact your service personnel.
RT Clock Need Reset	High	C	Contact your service personnel.
RT Clock Not Exist	High	C	Contact your service personnel.

Alarm message	Default priority	Indication on alarm reset	Cause and solution
XX V Too High	High	C	There is a problem with the system power supply. Restart the monitor.
XX V Too Low	High	C	

Note: XX represents 2.5 V, 3.3 V,5 V, or 12 V.

5.5.13 Recorder Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
Recorder Init Error	Low	A	An error occurred during the recorder initialization. If the alarm persists, contact your service personnel.
Recorder Comm Error	Low	A	Restart the monitor if not solved. If the alarm persists, contact your service personnel.
Recorder Head Hot	Low	C	The recorder has been working for too long time. Stop the recording and resume the recording till the recorder's print head cools down.
Recorder Initializing	Prompt	/	Wait until the recorder initialization is completed.
Recorder out of Paper	Prompt	/	The recorder paper is not loaded or the recorder door is not closed. Check the recorder, load the recorder paper or close the recorder door.
Recorder Busy	Prompt	/	The buffer queue for recording is full.

5.5.14 Printer Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
Printer Buffer Full	Prompt	/	The printer buffer is full. Wait till the printer finishes the printing task.
Fail	Prompt	/	The printer runs out of paper or cannot be connected. Check the printer.
Printing Stopped	Prompt	/	Printing is manually stopped.
Printer Unavailable	Prompt	/	The printer may fail. Check the printer.
PDF storage space is nearly full	Prompt	/	Delete the files saved under the PDF file path to release storage space. Otherwise you cannot save new PDF files.
Error storing PDF file	Prompt	/	The PDF file path settings on the printer server and the PDFCreator are not consistent or the PDF storage space is full. Check the PDF file path settings for consistency, or delete the files saved under the PDF file path to release storage space.

Alarm message	Default priority	Indication on alarm reset	Cause and solution
Change the print server language to be consistent with this monitor	Prompt	/	Verify that the language settings of the printer server and the monitor are consistent, Otherwise you cannot perform printing.
Print Server Disconnected	Prompt	/	Check that the monitor is properly connected with the printer server.

5.5.15 Technical Alarm Messages Related to Networked Monitoring

Alarm message	Default priority	Indication on alarm reset	Cause and solution
No CMS	Low	B	The monitor is disconnected from the CMS. Check the network connection.
View Bed XX YY-ZZ, Network Disconnected.	Low	A	The network is interrupted when the monitor is viewing the remote device. Check the network connection.
Viewed by Bed XX YY-ZZ, Network Disconnected.	Low	A	The network is interrupted when the monitor is viewed by another remote device. Check the network connection.
WLAN IP Address Conflict	Low	C	Wireless network IP network conflicts. Check the network settings.
LAN1 IP Address Conflict	Low	C	Wired network LAN1 IP network conflicts. Check the network settings.
Fail To Get WLAN IP Address	Low	C	Unable to automatically obtain the wireless network IP address. Check the network settings.
Fail To Get LAN1 IP Address	Low	C	Unable to automatically obtain the wired network LAN1 IP address. Check the network settings.

Note: XX refers to the department name, YY refers to the room number, and ZZ refers to the bed number.

5.5.16 Other System Technical Alarm Messages

Alarm message	Default priority	Indication on alarm reset	Cause and solution
Storage Card Error	High	C	The storage card fails or files are damaged. Restart the monitor to format the storage card. If the alarm persists, contact your service personnel.
Loading Default Config Failed	Low	A	The default configuration is not correctly loaded. The monitor will restore to the factory default configuration for the current patient category.

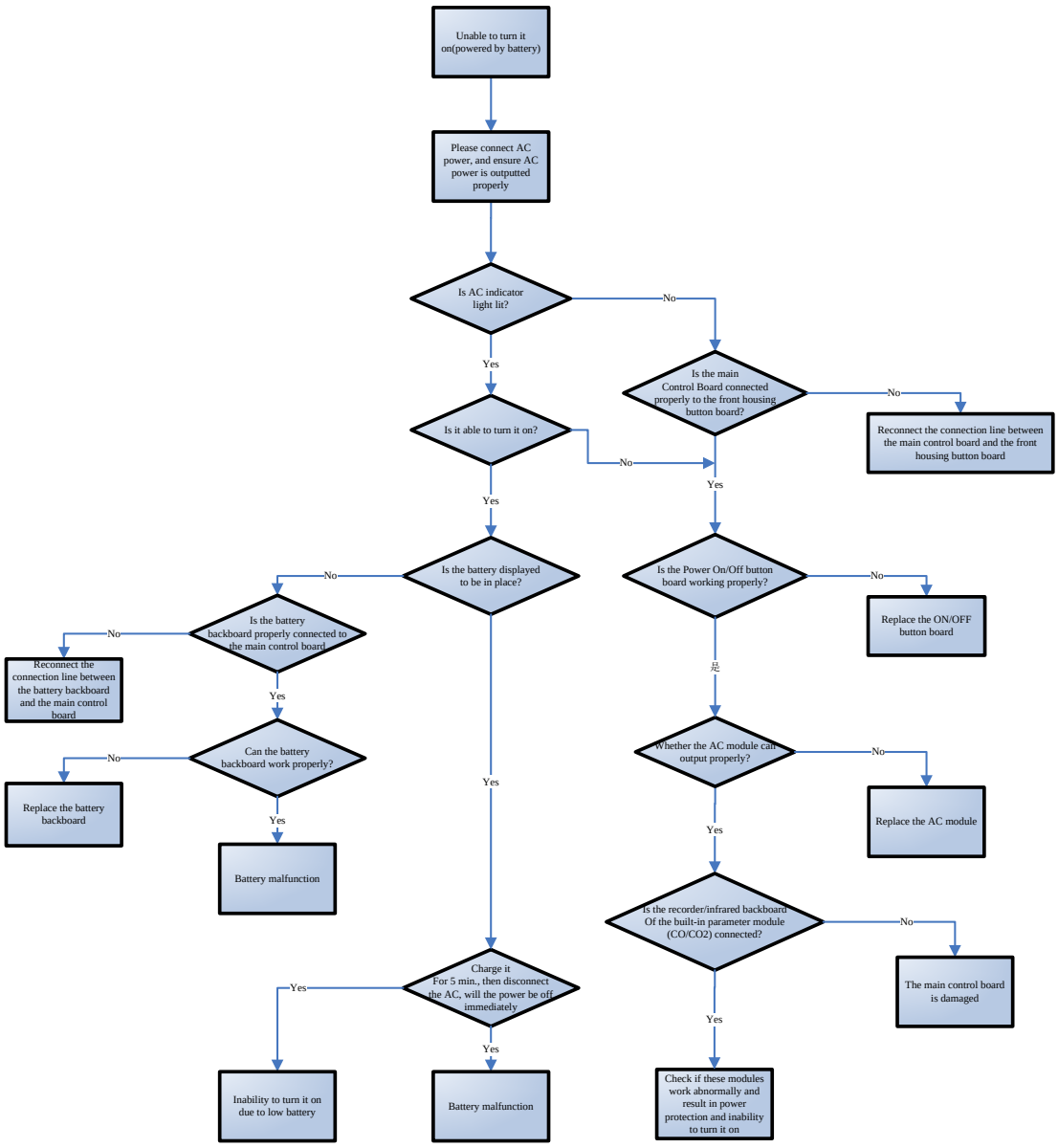
Alarm message	Default priority	Indication on alarm reset	Cause and solution
XX Conflicts (XX refers to the module label)	Prompt	/	The same type of corresponding module being used exceeds the supported number. Remove the conflict module.
XXX Measurement has been closed (XX refers to the module label)	Prompt	/	The parameter module is disabled. Switch on the module if you want to use it. For more information, see *3.11.1 Switching On or Off a Parameter*.
The display setup for XXX is disabled. (XX refers to the parameter label)	Prompt	/	The parameter of the newly inserted module is not displayed on the screen. Select a desired area to display the parameter numerics and waveforms. For more information, see *26.11 The Other Settings*.
The patient data storage space is nearly full. Please delete some discharged patients.	Configurable	B	Delete unnecessary earlier discharged patient.

5.6 Troubleshooting Guide

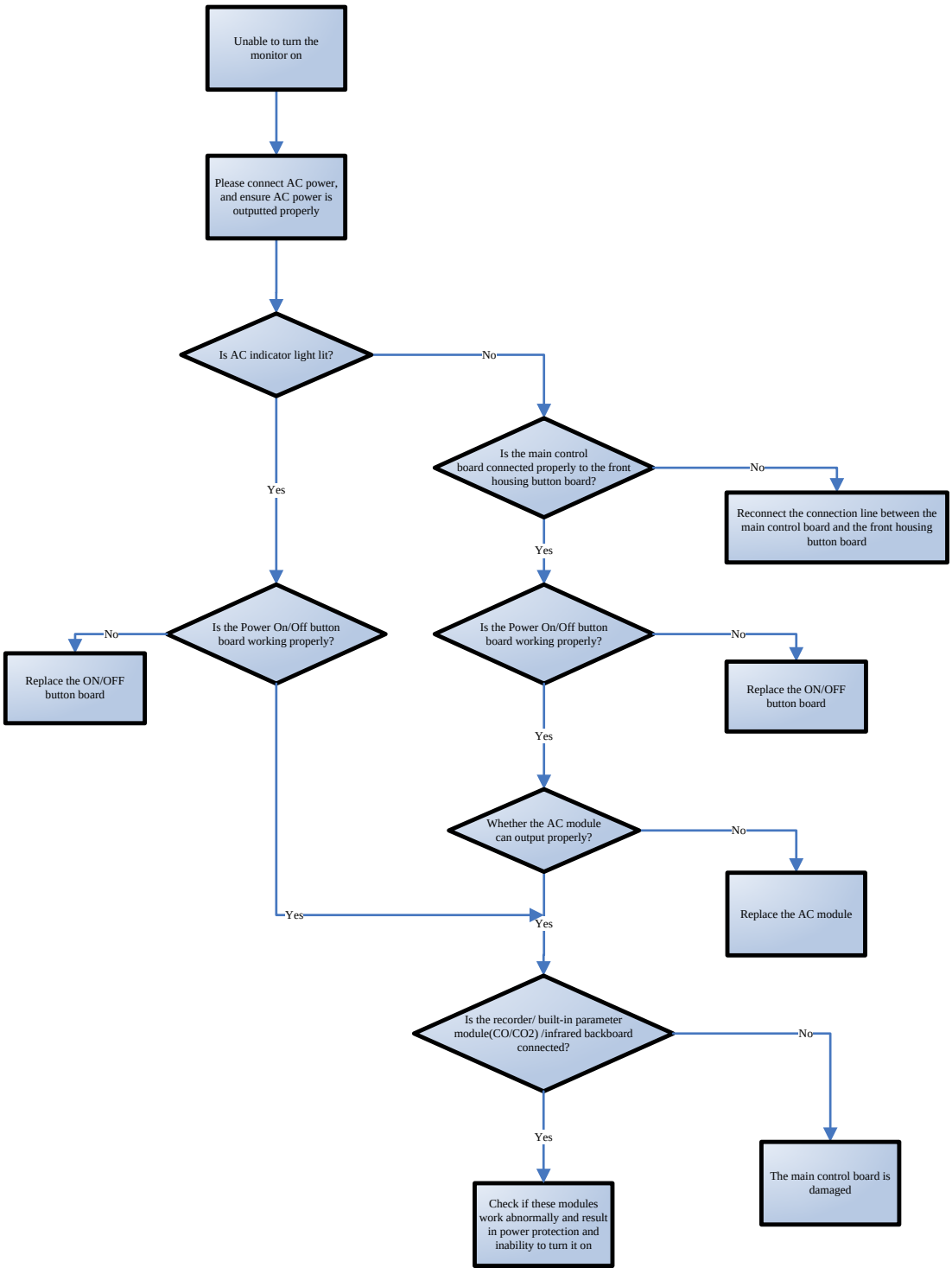
5.6.1 Problems with Turning on/off

Troubles	Possible causes	Troubleshooting
Unable to turn the monitor on	AC power is not connected, or a low battery or a damaged battery	■ Please confirm if the AC power is connected properly. ■ Check if the battery is low or if the battery is damaged.
	Connection line failure	■ Check if the line between the ON/OFF button board and the main control board is connected properly. ■ Check if the plug of the connection line and the corresponding socket are damaged.
	ON/OFF button board is damaged	Replace the ON/OFF button board
	Power module is damaged	Replace the power module
	The main control board is damaged	Replace the main control board
	Power protection	■ If there are other devices connected to the main unit, such as external parameter modules, USB flash drives and scanners, disconnect them from the main unit first. If you can turn it on after the disconnection, it's possible that abnormal external devices trigger power protection.

Troubles	Possible causes	Troubleshooting
		■ If there are no other devices connected to the main unit, check the backboard of integral module rack or the main control board to see if there are short circuits which result in power protection.



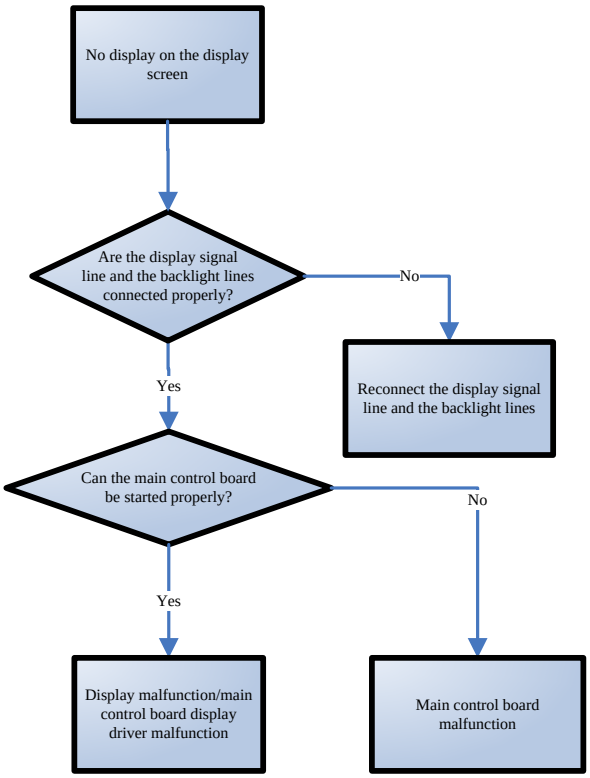
Troubleshooting flowchart for the inability to turn it on due to battery failure



Troubleshooting flowchart for the inability to turn it on due to AC power failure

5.6.2 Display Failures

Troubles	Possible causes	Troubleshooting
Unable to display, or abnormal display, but the main unit can work	Connection line failure	■ Check if the display is properly connected to the main control board (screen and backlight line). ■ Check if the line plug and corresponding socket are damaged
	LCD display is damaged	Replace the front housing assembly
	Main control board software goes wrong	Update the main control board software
	The backlight drive is damaged	Change the main control board
	The display drive is damaged	Change the main control board
The touch screen does not respond.	Connection line failure	■ Check if the touch screen is properly connected to the main control board ■ Check if the line plug and corresponding socket are damaged
	The touch screen is damaged	Replace the front housing and touch screen repair kit
	Main control board software goes wrong	Update the main control board software
	The main control board is damaged	Change the main control board



Display troubleshooting flowchart

5.6.3 Alarm Failures

Troubles	Possible causes	Troubleshooting
The alarm indicator light is always off or always on, but the alarm sounds generated properly.	Connection line failure	■ Check if the alarm light board is properly connected to the main control board. ■ Check if the connection line or plug is damaged.
	Alarm indicator light board is damaged	Replace the alarm indicator light board
	The main control board is damaged	Change the main control board
No alarm sound is generated, but the alarm indicator light works properly.	Alarm sound is turned off	Check whether the alarm sound is set to be silent; select [Main Menu] → [System >>] → [Maintenance >>] → enter the user maintenance password → [Alarm >>], and adjust the [Minimum Alarm Volume] to an appropriate value in the pop-up menu. Select [Alarm] → [Setup] on the main menu to adjust the alarm volume.
	Speaker damage	Replace the speaker
	Connection line failure	Check if the speaker is properly connected to the main control board.
	The main control board is damaged	Change the main control board

5.6.4 Recorder Failures

Troubles	Possible causes	Troubleshooting
The recorder is unable to print	Recorder module is not allowed	Check if the recorder's work indicator light is on. If it is on, restore its function in the factory maintenance.
	There's a paper jam	Reinstall printing paper
	Connection line failure	■ Check if the recorder is properly connected to the main control board. ■ Check if the connection line or plug is damaged.
	The recorder is damaged	Replace the recorder
	The main control board is damaged	Change the main control board
Poor printing effect	Thermal-sensitive coating of the printing paper fails	Replace the printing paper
	The thermal head is dirty	Clean the thermal head
	The recorder is damaged	Replace the recorder

5.6.5 Output Interface Failures

Troubles	Possible causes	Troubleshooting
Nurse call signal is not outputted	The main control board is damaged	Change the main control board.
USB Device Unusable.	The main control board is damaged	Change the main control board.
The network interface cannot be used	The main control board is damaged	Change the main control board.
VGA interface cannot be used	The display does not match with the timing sequence of VGA interface	Please confirm whether the display supports the resolution of 1280*800 (10-inch/12-inch model) or 1376 * 768 (15-inch).
	The main control board is damaged	Change the main control board.

5.6.6 Battery Failures

Troubles	Possible causes	Troubleshooting
Battery cannot supply power	Battery is damaged	Replace the battery
	Connection line failure	■ Check if the main control board is properly connected to the battery interface board. ■ Check if the connection line or plug is damaged.
The battery cannot be fully charged or cannot be charged	Battery is damaged	Replace the battery
	Connection line failure	■ Check if the main control board is properly connected to the battery interface board. ■ Check if the connection line or plug is damaged.
	The main control board is damaged	Change the main control board

5.6.7 Parameter Module Failures

Troubles	Possible causes	Troubleshooting
ECG/Resp/SPO_2 (Mindray)/NIBP/Temp/IBP do not work	Incorrect software version	Check the MPM and system software versions and update the software
	Parameter circuit is damaged	Change the main control board
	Connection line failure	■ Confirm whether the parameter board and the main board are properly connected. ■ Confirm if these connection lines and connectors are intact.
	Accessories may be damaged	Replace the accessories.
	Check whether the parameter configuration is correct	According to the user manual, confirm whether the corresponding parameter configuration has been opened
SPO_2 module (nellcor) cannot work	Accessories may be damaged	Replace accessories
	SPO2 module failure	Replace the module.
CO_2 (built-in) module cannot work	Internal air pipe connection failure	■ Check if the internal air pipe is properly connected ■ Check if the internal air pipe is damaged

Troubles	Possible causes	Troubleshooting
	System software configuration error	Check if the modules in the system software are configured correctly.
	The module is damaged	Replace the module
	Connection line failure	■ Check if the CO_2 module is properly connected to the main control board. ■ Check if the line is damaged
	The main control board is damaged	Change the main control board
C.O. (built-in) module cannot work	System software configuration error	Check if the modules in the system software are configured correctly.
	The module is damaged	Replace the module
	Line connection failure	■ Check if the parameter board is properly connected to the C.O. module and the C.O. module is properly connected to the main control board. ■ Check if the connection line is damaged
	The main control board is damaged	Change the main control board

5.6.8 Network Failures

Troubles	Possible causes	Troubleshooting
Frequent disconnection of network	The network cable is not properly connected.	Check if the network cable is connected properly, or whether the network cable is too close to the power cable of a high-power device, or whether the network cable is too long (cannot exceed 50m).
	Network settings error	Check for IP conflicts in the network. If yes, reset the network.
The network has been connected, the Viewbed function cannot be realized	The network cable is not properly connected	Check if the network cable is connected properly, or whether the network cable is too close to the power cable of a high-power device, or whether the network cable is too long (cannot exceed 50m).
	Have got too many monitors under observation	Confirm the number of monitors that can be connected at the same time according to the user manual.

Troubles	Possible causes	Troubleshooting
	Network settings error	Check for IP conflicts in the network. If yes, reset the network.
WLAN cannot be connected	Network settings error	Check whether WLAN settings are correct.
	The antenna is not properly installed	Please check if the antenna of the wireless network card is properly connected to the wireless module.
	Wireless module is damaged	Please replace the wireless module.
	The main control board is damaged	Replace the main control board.

5.6.9 Software Upgrade Failures

Troubles	Possible causes	Troubleshooting
Program upgrade fails	Connection error	■ Check if the network cable is connected to the monitor's network interface instead of iView's network interface. ■ Make sure the hub or switch can work properly and check if the hub is properly connected.
	Program upgrade package error	Please select the correct upgrade package.
	Error in the IP address setting of PC	Set a fixed IP address for the upgraded monitor within the specified Class C addresses. It is not recommended to upgrade the program in a network with multiple PCs connected.

6 Upgrade

6.1 Introduction

This monitor supports upgrade of the monitoring parameter function module, function component, and software.

Precautions

- **Before upgrading the function of a monitor to be disassembled, eliminate static electricity. When disassembling components with electrostatic sensitive mark, wear ESD wristband or gloves to avoid damage to the components.**
- **During reinstallation, connect and place cables properly to avoid crushing the cables, which may cause a short circuit.**
- **During reinstallation, select screws with proper model. If you forcibly tighten improper screws, the device may be damaged. And the screws or components may become loose during use, which causes unpredictable product damage or personal injury.**
- **Disassemble the device based on the disassembly sequence. Otherwise, an irreversible damage may be caused to the device.**
- **Before disassembling components, ensure that all connected cables are removed. During disassembly, avoid pulling off the cables or damaging the connectors.**
- **Loosened screws and other parts should be categorized and placed properly so that they can be used for reinstallation and will not be dropped, polluted or lost.**

6.2 Parameter Function Module Upgrade

This monitor supports upgrade of the following parameter function modules:

Embedded Parameter Module	PN	Name and Specification	Remarks
IBP module	115-059953-00	Integrated IBP material package FRU	
C.O. module	115-059954-00	Integrated C.O. material package FRU	
Sidestream CO_2 module	115-059974-00	Integrated 10/12-inch sidestream CO_2 material package FRU	
Microstream CO_2 module	115-059956-00	Integrated microstream CO_2 material package FRU	
Mainstream CO_2 module	115-059957-00	Integrated mainstream CO_2 material package FRU	

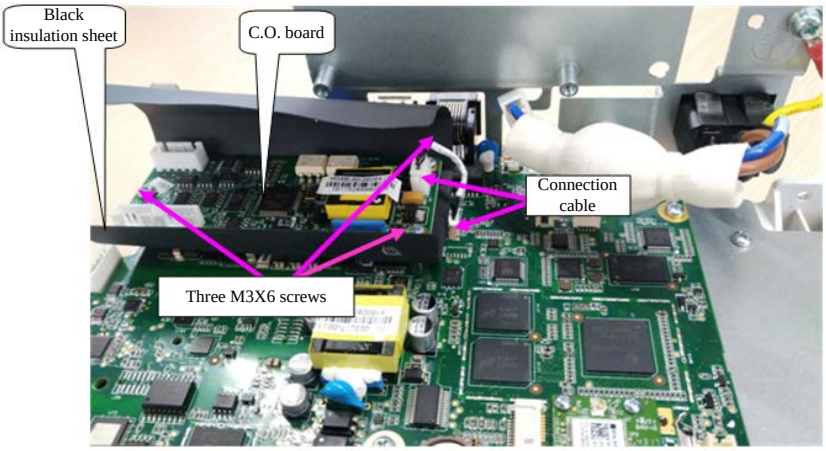
For details about the use method of different parameter modules, see ePM series user manual. The following content describes the upgrade methods of the parameter modules:

6.3 Upgrading Parameter C.O. Function Module

When upgrading the C.O. function, install the upgrade material packag.

The operation procedure is as follows:

1. Disassemble the main control board by referring to section "Disassembling Main Control Board" in the Disassembly and Repair part.
2. Install the C.O. board in the material package to the main control board by referring to "Disassembling C.O. Board".



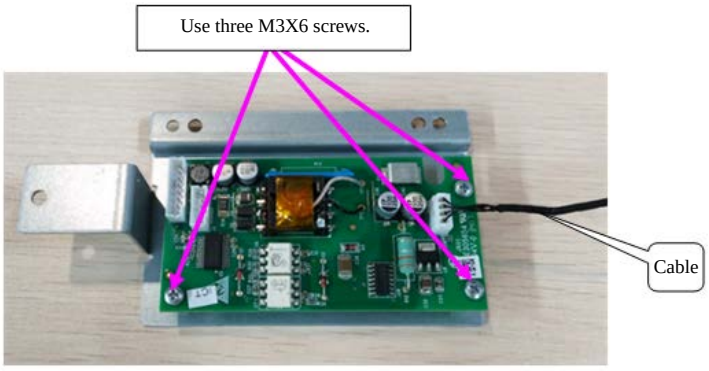
3. Reassemble the machine.
4. Start the monitor, and choose [**Main Menu**] > [**Maintenance**] > [**Factory Maintenance**] > [**Factory Default**], enable [**C.O.**], and restart the machine to validate the configuration.
5. Test the upgraded machine by referring to "C.O. Test" in the Module Performance Test part.

6.4 Upgrading the Gas Module

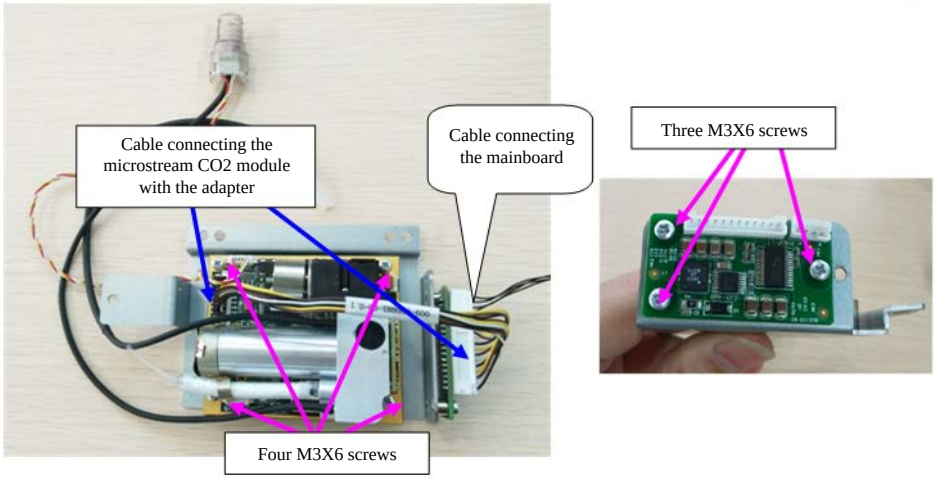
When upgrading the gas function, use the material in the upgrade material package to replace the gas module, cables connecting the gas module and main control board, and cables connecting the gas module and parameter face head.

The operation procedure is as follows:

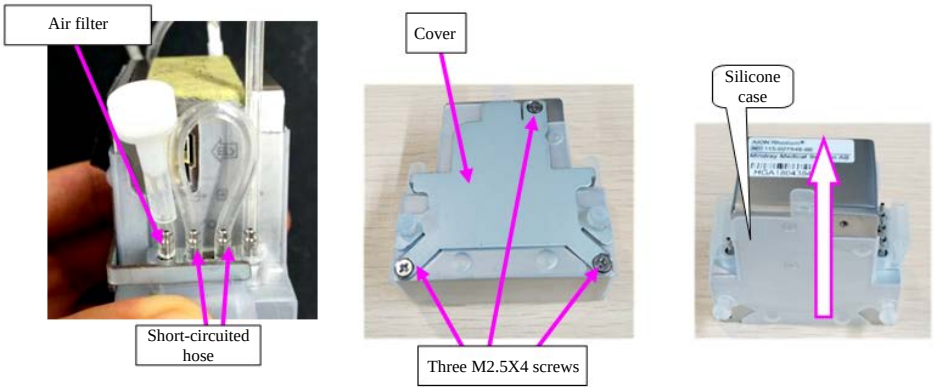
1. Separate the front and rear housings of the machine by referring to "Disassembling Front and Rear Housings" in the Disassembly and Repair part.
2. Connect the mainstream CO_2 module, microstream CO_2 module, and sidestream CO_2 module in the material package using sheet metals and cables by referring to "Disassembling Gas Module" in the Disassembly and Repair part. The machine supports only single gas module upgrade.



Mainstream CO_2 module composition diagram

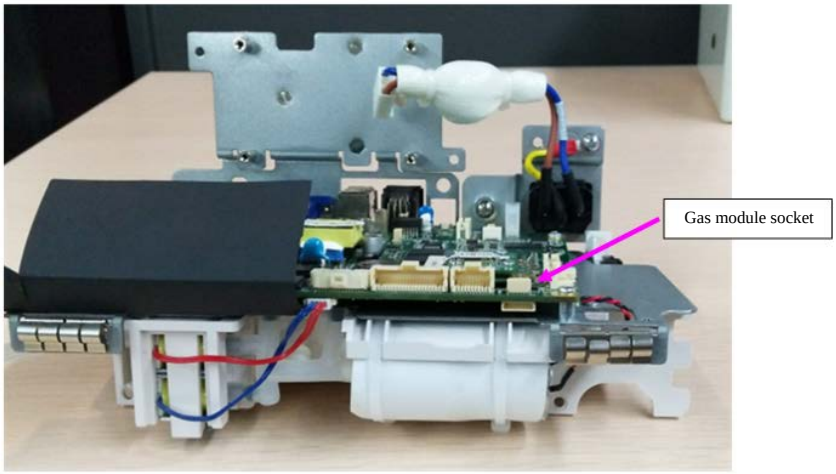


An microstream CO_2 module is used.



Sidestream CO_2 module composition diagram

3. Fix the gas module to the bracket of the machine rear housing, and connect it with the main control board.



4. Reassemble the machine.
5. Start the monitor, and choose [**Main Menu**] > [**Maintenance**] > [**Factory Maintenance**] > [**Factory Default**], select [**Support CO_2 Class**] to correspond with the upgraded gas module, and restart the machine to validate the configuration.
6. Test the upgraded machine by referring to "Gas Module Test" in the Module Performance Test part.

6.5 Function Component Upgrade

Precautions

- **When upgrading the WiFi and analog output functions of a standard configuration host, use the board in the material package to replace the board in the monitor, in addition to installing corresponding function components into the monitor.**

This monitor supports upgraded WiFi components and recorder components.

Function Component	PN	Name and Specification	Remarks
Recorder	115-059807-00	Recorder material package FRU	
WiFi	115-059923-00	Integrated WiFi material package FRU	

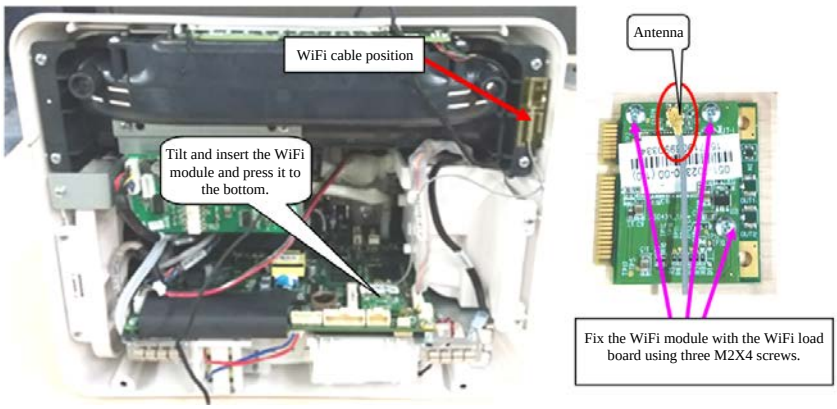
This monitor is configured with the WiFi function by building a WiFi through a wireless AP. Only the engineers or personnel specified by Mindray are qualified for the WiFi building and setting as well as performance test.

6.5.1 Upgrading WiFi Function

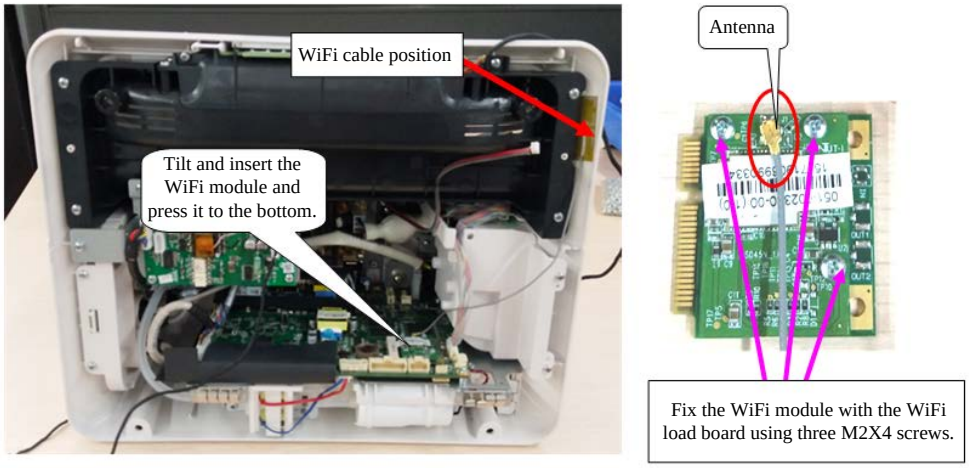
When upgrading the WiFi function, use the material in the upgrade material package to replace the WiFi module and connected dual-band antennas.

The operation procedure is as follows:

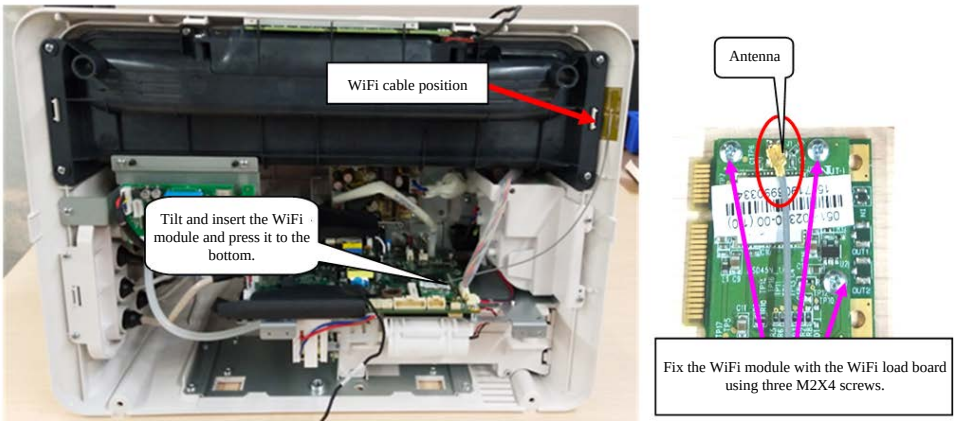
1. Disassemble the main control board by referring to section "Disassembling Main Control Board" in the Disassembly and Repair part.
2. Install the WiFi module to corresponding socket of the main control board by referring to the "Disassembling WiFi Module", and attach the antennas to corresponding rear housing of the machine.



ePM 10/ePM 10A/ePM 10C Host



ePM 12/ePM 12A/ePM 12C Machine



ePM 15/ePM 15A/ePM 15C Machine

3. Sort the antennas, install the main control board, and reinstall the machine.
4. Start the machine, and test whether the WiFi function is normal.

5. To use the WiFi function, refer to its user manual.

Precautions

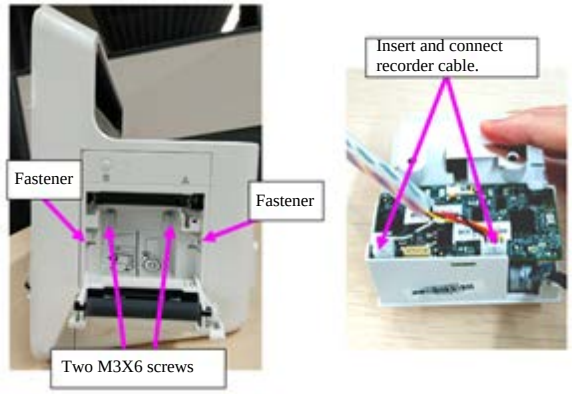
- **If the antennas are not installed in the right position, the WiFi signal quality will be affected.**

6.5.2 Upgrading Recorder Function

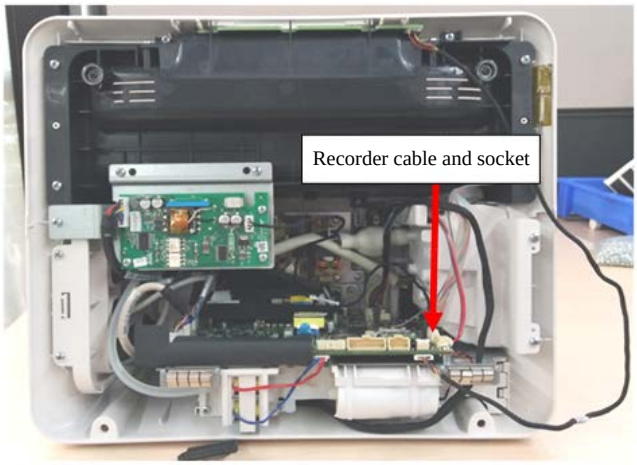
When upgrading the recorder function, use the material in the upgrade material package to replace the recorder and cables connecting the recorder and main control board.

The operation procedure is as follows:

1. Separate the front and rear housings of the machine by referring to "Disassembling Front and Rear Housings" in the Disassembly and Repair part.
2. Install the recorder to the bracket of the rear housing recorder by referring to "Disassembling Recorder".



3. Fix the recorder module to the bracket of the machine rear housing, and connect it with the main control board.



4. Reassemble the machine.
5. Start the monitor, choose [**Main Menu**[> [**Maintenance**] > [**Factory Maintenance**] > [**Factory Default**], enable [**Recorder**], and restart the machine to validate the configuration.
6. Start the machine, and test whether the recorder function is normal.

6.6 Software upgrade

This monitor supports upgrade through a PC, network or USB disk. Using one of the methods, you can complete update of the monitor machine and peripheral related firmware.

- This monitor can be upgraded using the network upgrade software (PN: 110-006403-00 PC upgrade tool) of Mindray monitor. The software can directly run on a mobile or desktop PC. You can upgrade the following programs of the monitor by network connection or using crossover cables to connect the monitor with a PC.
- The monitor can also be upgraded using USB disk with specified authorization (containing the USB disk upgrade Bootstrap PN: 110-004854-00). You can upgrade the following programs of the monitor.

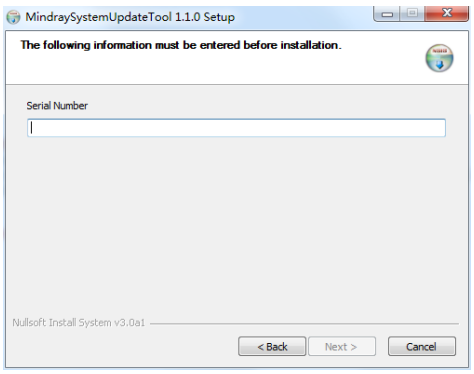
Software	PN	Name and Specification	Remarks
System software package	/	ePM system package	/
Module rack software	/	FPGA chip-write software	/
ePM - multi-parameter module	/	M51C_Mindray monitoring algorithm (extensible ARR)	ECG configuration software
	/	M51C_Mindray monitoring algorithm (extensible ARR_12-lead ST)	ECG configuration software
	/	M51C_Mindray monitoring algorithm (extensible ARR + 12-lead ST + Glasgow12-lead resting)	ECG configuration software
	/	M51C_Mindray monitoring algorithm (extensible ARR + 12-lead ST + Glasgow12-lead resting)	ECG configuration software
	/	M51C_Mindray monitoring algorithm (heart rate meter + Glasgow12-lead diagnosis)	ECG configuration software
	/	M51C_Mindray monitoring algorithm (heart rate meter)	ECG configuration software
	/	M51C_Mindray monitoring algorithm (extensible ARR + 12-lead ST + Mindray12-lead resting)	ECG configuration software
	/	M51C_Mindray monitoring algorithm (fatal ARR)	ECG configuration software
	/	DSP (BF70x) Bootstrap of ePM multi-parameter module	DSP Bootstrap
	/	IBP function program of ePM multi-parameter module	IBP function upgrade

Software	PN	Name and Specification	Remarks
			program
	/	Mindray SpO_2 function program of ePM multi-parameter module	Mindray SpO_2 function upgrade program
	/	DSP (BF70x) function program of ePM multi-parameter module	DSP function upgrade program
IBP module	/	Chip-write software of M03B module	/
C.O. module	/	Chip-write software of M03B module	/
M02D module	/	Program software of M02D function	
Power firmware	/	Chip-write software of power firmware	/
Receiver box module	/	Firmware software of receiver box module	/

6.6.1 Network Upgrade Tool

6.6.1.1 Installing Tool Software

1. Click the execution program SystemUpdateTool.exe of the tool software. A page is displayed. Click Next > to enter the page requiring you to input the **Serial Number**.



2. Input the **Serial Number**, and click Next > to enter the installation position page of the program. Select corresponding installation folder, and follow the wizard to click Next > to complete the installation.

Appendix: Multilingual Reference Table

Language (English)	Language (Chinese)	Remarks
ENGLISH	英语	/
SIM.CHINESE	简体中文	/
FRENCH	法语	/
GERMAN	德语	/
ITALIAN	意大利语	/
POLISH	波兰语	/
SPANISH	西班牙语	/
PORTUGUESE	葡萄牙语	/
RUSSIAN	俄语	/
CZECH	捷克语	/
TURKISH	土耳其语	/
HUNGARIAN	匈牙利语	/
Danish	丹麦语	/
Dutch	荷兰语	/
Finnish	芬兰语	/
Norwegian	挪威语	/
Swedish	瑞典语	/
Romanian	罗马尼亚	/
Serbian	塞尔维亚	/
GREEK	希腊语	/
TRA.CHINESE	繁体中文	/
Japanese	日语	/

6.6.1.2 Connecting the Monitor with a PC

Ensure that at least one NIC is installed on a PC correctly. The monitor is connected with the PC through this NIC.

1. Connect the monitor with the PC using a hub.
   - ◆ Connect the PC with the hub using a network cable. Insert one end of the network cable to the NIC slot of the PC, and insert the other end of the network cable to the slot of the hub.
   - ◆ Connect the monitor with the hub using a network cable. Refer to the PC and hub connection method. The hub has multiple slots, so it can be connected with at least 5 monitors to upgrade them concurrently.
2. Modify the IP address of the PC NIC.

Precautions

- **Before running the upgrade program, set the IP address to 77.77.1.xx to ensure normal upgrade. The gateway and DNS can be set as necessary. For example, the IP address is set to 77.77.1.13, and the subnet mask is set to 255.255.255.0.**

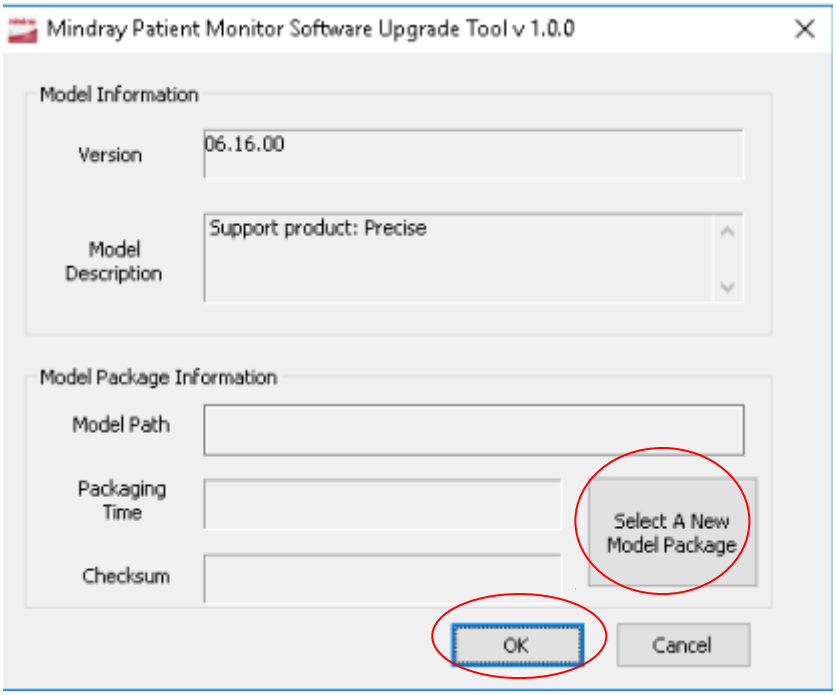
Methods of entering the upgrade mode:

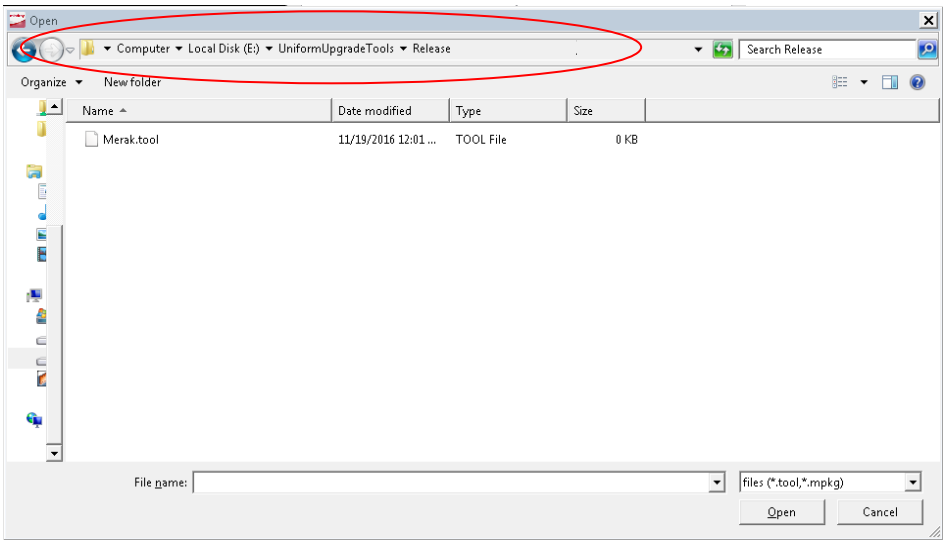
- Connect the monitor with a USB keyboard, and press F4+F5 or * repeatedly during startup to enter the upgrade mode.
- Slide on the touch screen using two or more fingers to enter the upgrade mode during startup.

6.6.1.3 Setting Software Upgrade

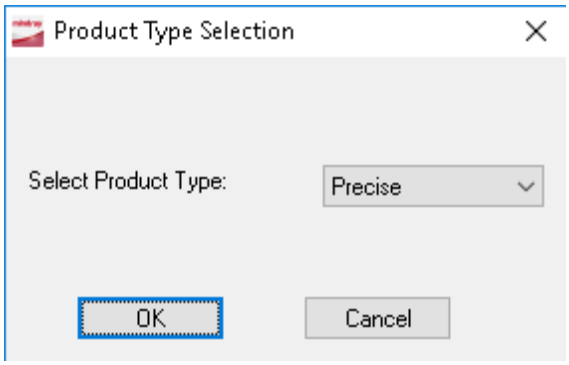
Based on the previous configuration requirements, the software upgrade packages of different products need to be set. The setting is performed and managed by the administrator only. Set system software upgrade:

1. Download the ePM system software package (stored in the model package directory), run the installed system (network) upgrade tool software, select [**Select a New Model Package**] >[**Precise. Tool**], and click [**Open**] and [**Confirm**], as shown in the following figure:

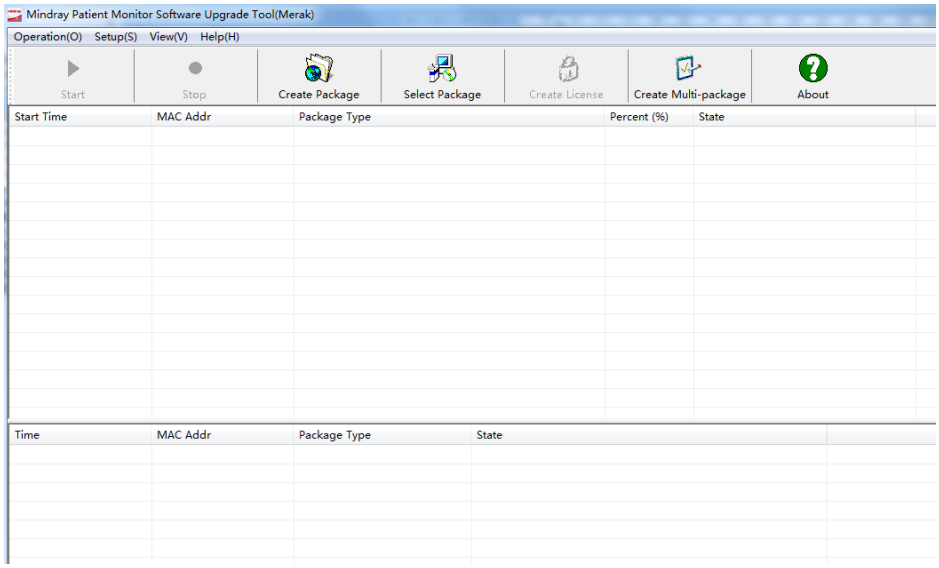




2. In the [**Product Type Selection**] dialog box, select [**Precise**] in the [**Select Product Type**].



The following page is displayed on the PC:



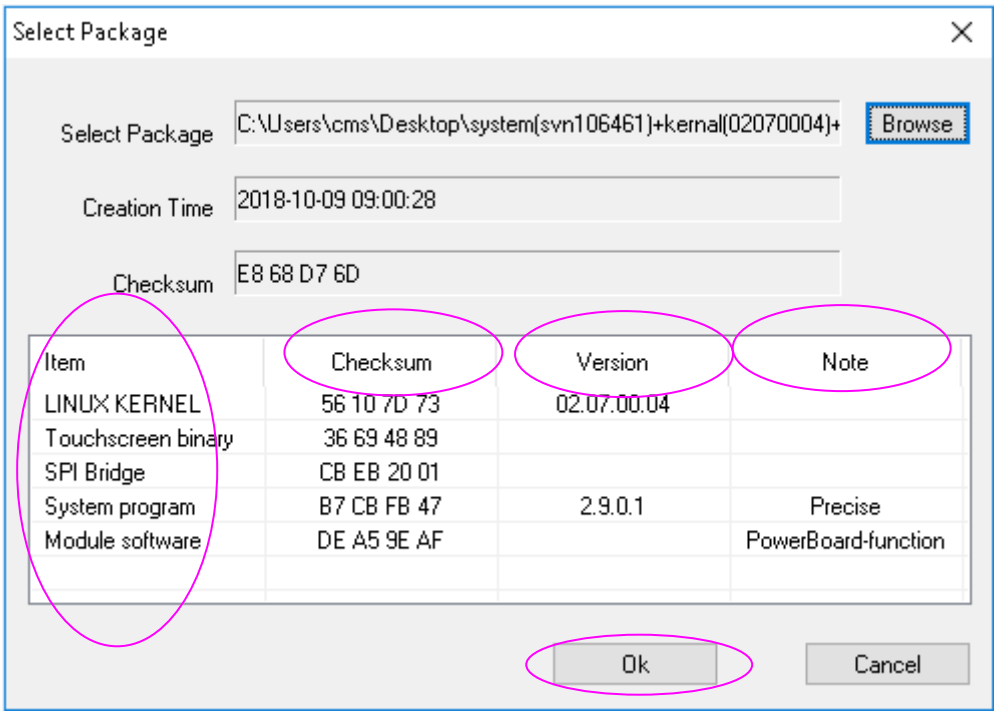
6.6.2 Software Upgrade

6.6.2.1 Upgrading System Software and Internal Plugin Cable

1. Enter the system upgrade and download page, and click 

.
2. Browse the prepared system software upgrade package files, and verify whether the download content, including item, checksum, version, and note is correct, and click [**Confirm**].

   The [**Start**] hot key is lit up in the main menu.



3. Confirm that the network cable is connected correctly and the monitor is stopped, and click the [**Start**] hot key to download the software.

6.6.2.2 Upgrading Module Software

Upgrade the module program files by referring to the System Software Upgrade Method. After they are upgraded, click [**Stop**] in the upgrade menu, remove the network cable, and stop and restart the monitor.

For details about the network program upgrade method, refer to the user manual and help of the Mindray monitor network upgrade software or consult the after-sales service personnel of Mindray.

6.6.3 Upgrade by USB Disk

6.6.3.1 Preparing USB Disk Upgrade Directory Structure

Prepare the following required tool:

- USB disk: 2 GB or larger ordinary FAT USB disk, for example, Kingston or Netac.

1. Create UPGRADE_AMP\Precise in the root directory of the USB disk.
2. Copy the upgrade Bootstrap Precise-Installer.pkg to the UPGRADE_AMP\Precise directory.
3. Copy the upgrade file (PKG or MPKG) to the UPGRADE_AMP\Precise directory.

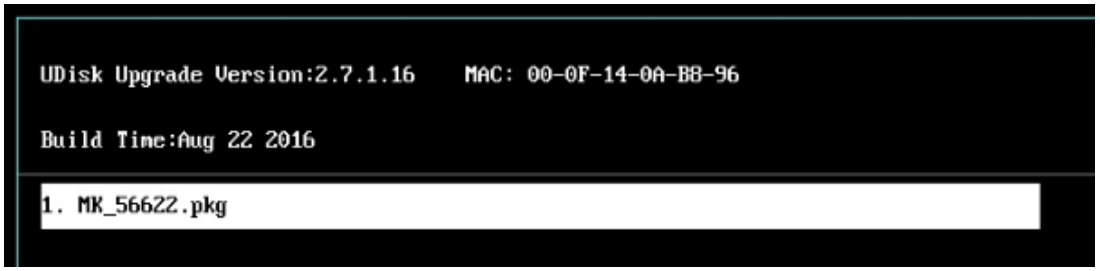
6.6.3.2 Inserting the USB Disk into the USB Port of the Monitor

Insert the prepared USB disk into any USB port of the main control board.

6.6.3.3 Triggering Upgrade Mode

- Method 1. Slide on the touch screen using two or more fingers to enter the upgrade mode during startup.
- Method 2: Connect the monitor with a USB keyboard, and press F2+F3, F4+F5, or * repeatedly during startup to enter the upgrade mode.

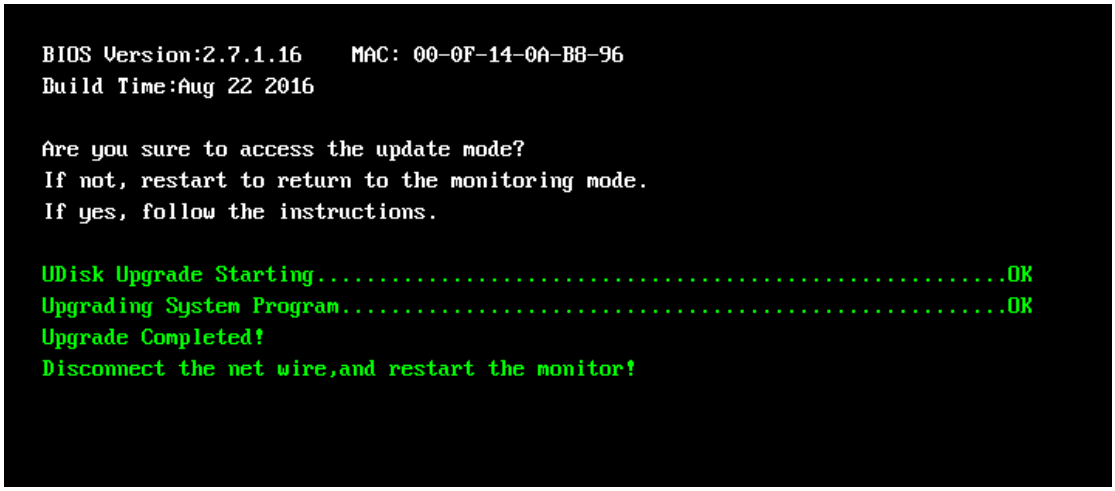
6.6.3.4 Selecting Upgrade File



- If there is only one upgrade file, it is selected by default. If there are multiple upgrade files, they are displayed in two columns. A maximum of 16 upgrade files can be displayed, which should not be exceeded. Click the up/down/right/left keys to switch to required upgrade file.
- Click DOWN ↓ on the touch screen to select an upgrade file downward, or press ↓ on the keyboard to select one.
- Click UP ↑ on the touch screen to select an upgrade file upward, or press ↑ on the keyboard to select one.
- Click LEFT ← on the touch screen to select an upgrade file rightward, or press ← on the keyboard to select one.
- Click RIGHT → on the touch screen to select an upgrade file rightward, or press → on the keyboard to select one.
- Click OK Enter on the touch screen to confirm the selected upgrade file, or press [Enter] on the keyboard to confirm the selection.

6.6.3.5 Completing Upgrade Process

If the following page is displayed, the upgrade is complete. Stop and restart the monitor to validate the upgrade.



⚠ Attention

- **Before the upgrade, disconnect the monitor from a patient and save important data in the monitor.**
- **During upgrade of the Bootstrap and FPGA, do not stop or power off the monitor. Otherwise, the device will be corrupted.**
- **Program upgrade can be performed by professional maintenance personnel only. Failure to avoid any maintenance warning may cause slight personal injury, product fault, or property loss.**

Precautions

- **After the Bootstrap is upgraded, re-upgrade the system program or other programs to ensure their compatibility.**
- **Before upgrade, ensure that the version of the upgrade package is the required one. To obtain the latest upgrade package, contact the product after-sales service department of this company.**

FOR YOUR NOTES

7 Maintenance and Disassembly

7.1 Tool

Before disassembling or replacing parts, the following tools may be used:

- Small Phillips screwdriver
- Phillips screwdriver
- Tweezers
- Needle-nose pliers
- Cutting pliers

7.2 Preparations

Before disassembling the monitor, make the following preparations:

- Stop monitoring the patient, power off the monitor, and disconnect all attachments and external devices.

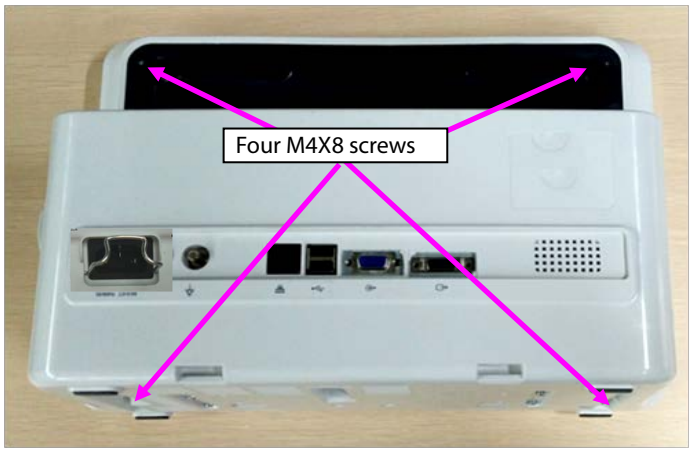
⚠ Warnings

- **Before disassembly, eliminate static electricity. When disassembling components with electrostatic sensitive mark, wear ESD wristband or gloves to avoid damage to the components.**
- **During reinstallation, connect and place cables properly to avoid crushing the cables, which may cause a short circuit.**
- **During reinstallation, select screws with proper model. If you forcibly tighten improper screws, the device may be damaged. And the screws or components may become loose during use, which causes unpredictable product damage or personal injury.**
- **Disassemble the device based on the disassembly sequence. Otherwise, an irreversible damage may be caused to the device.**
- **Loosened parts should be categorized and placed properly so that they can be used for reinstallation and will not be dropped, polluted or lost.**
- **During reinstallation, install the components prior to the host, and connect and place cables and hoses properly.**
- **The machine has waterproof requirement. During reinstallation, ensure that waterproof case and other waterproof materials are assembled properly.**

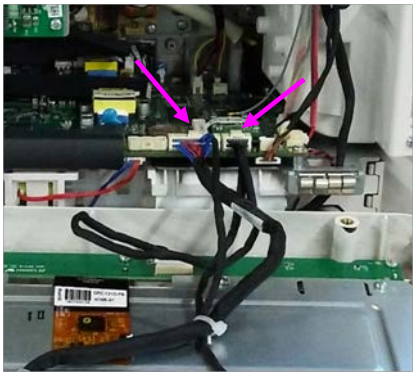
7.3 ePM 15/ePM 15A/ePM 15C Host Disassembly

7.3.1 Disassembling Front/rear Housing Components of Host

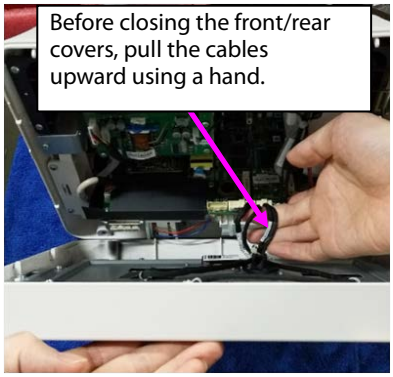
1. Use a Phillips screwdriver to loosen four M4X8 screws.



2. Open the front/rear housings, and remove the display screen connection cable and keypad connection cable.

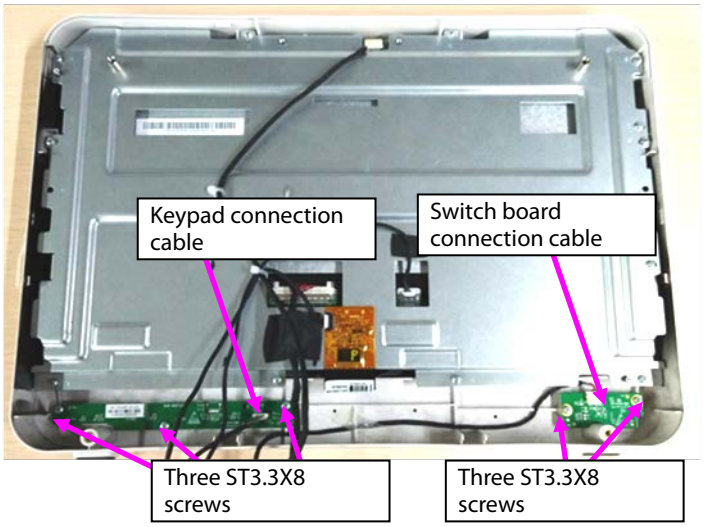


Note: During reassembly, close the front/rear covers and pull the cables upward using a hand.



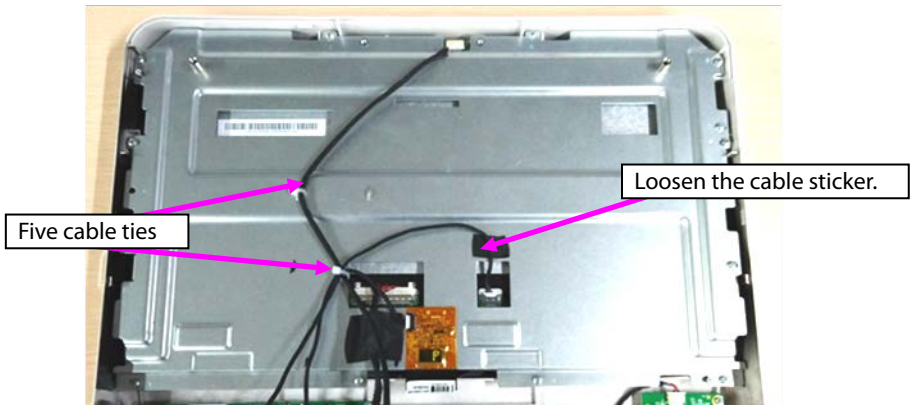
7.3.2 Disassembling Keypad and Switch Board

1. Remove the keypad connection cable, loosen the three ST3.3X8 screws shown in the figure, and take the keypad out.
2. Remove the switch board connection cable, loosen the two ST3.3X8 screws shown in the figure, and take the switch board out.

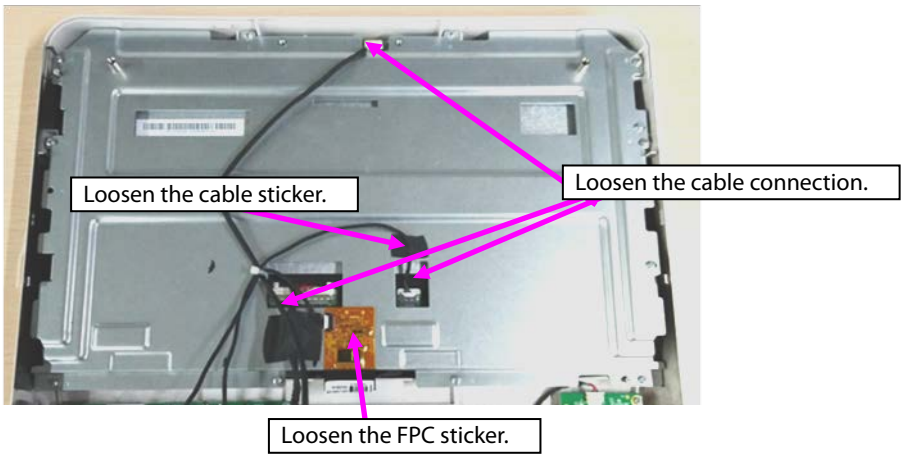


7.3.3 Disassembling Display Screen and Alarm Indicator

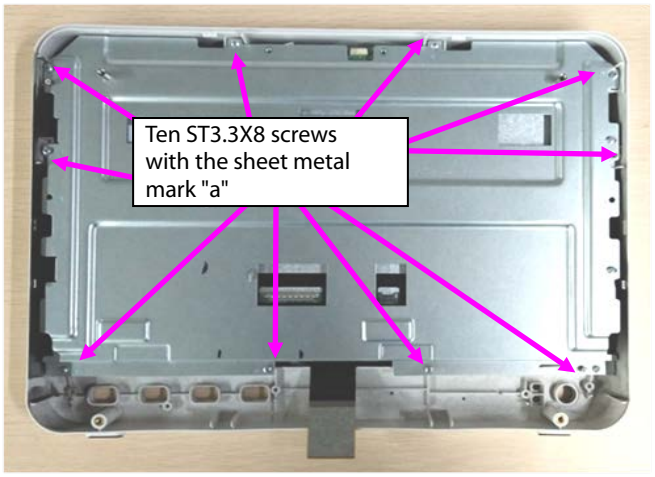
1. Remove the five cable ties from cables.



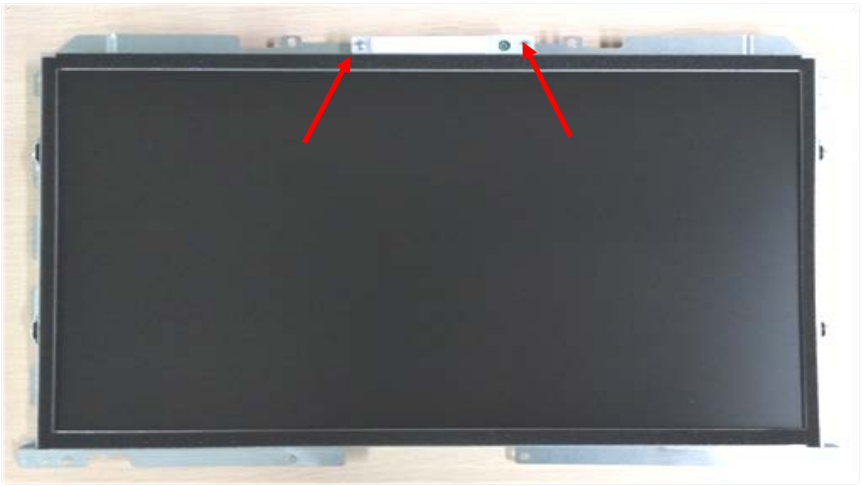
2. Remove the cables connecting with the touch screen, display screen, and alarm indicator.
3. Loosen the sticker connecting the touch screen PFC with the sheet metal and the cable stuck to the sheet metal.



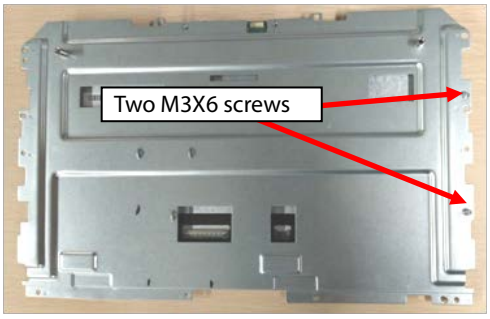
4. Loosen the ten ST3.3X8 screws shown in the figure, and remove the display screen component.

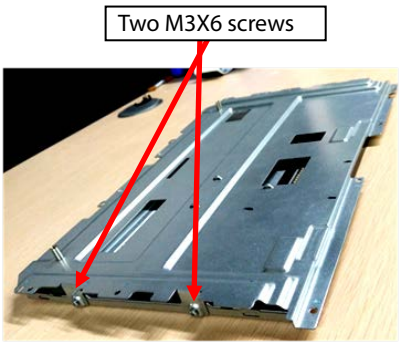


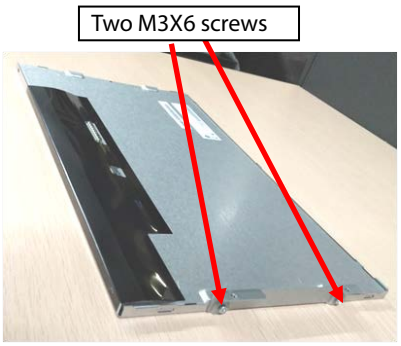
5. Loosen the two M3X6 screws, and take the alarm indicator board out.



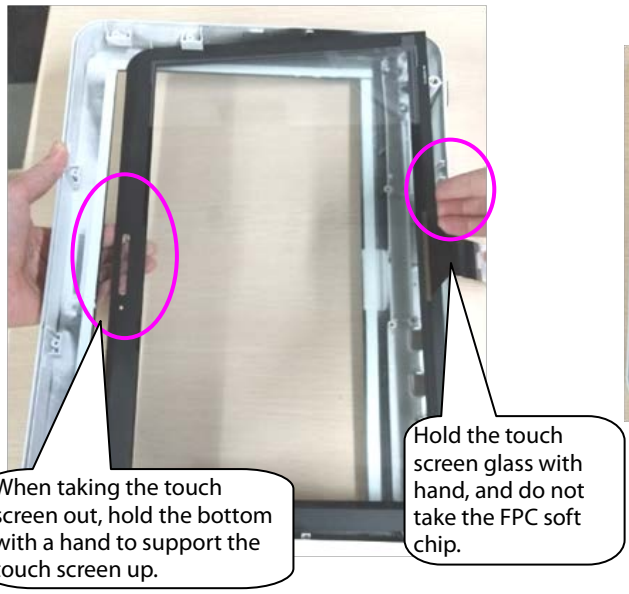
6. Loosen the two M3X6 screws with the mark "b" on the right top of the sheet metal.
7. Loosen the two M2X4 screws at the left side of the sheet metal.
8. Loosen the two M2X4 screws at the left side of the sheet metal, and take the display screen out.

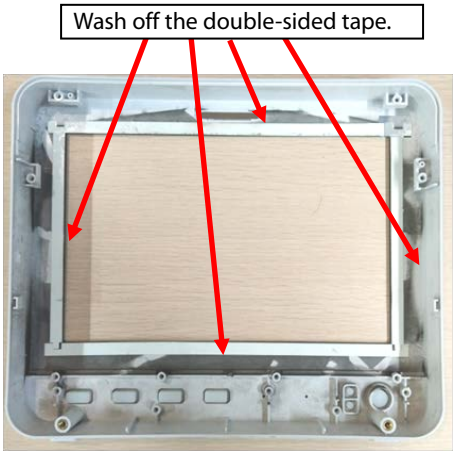




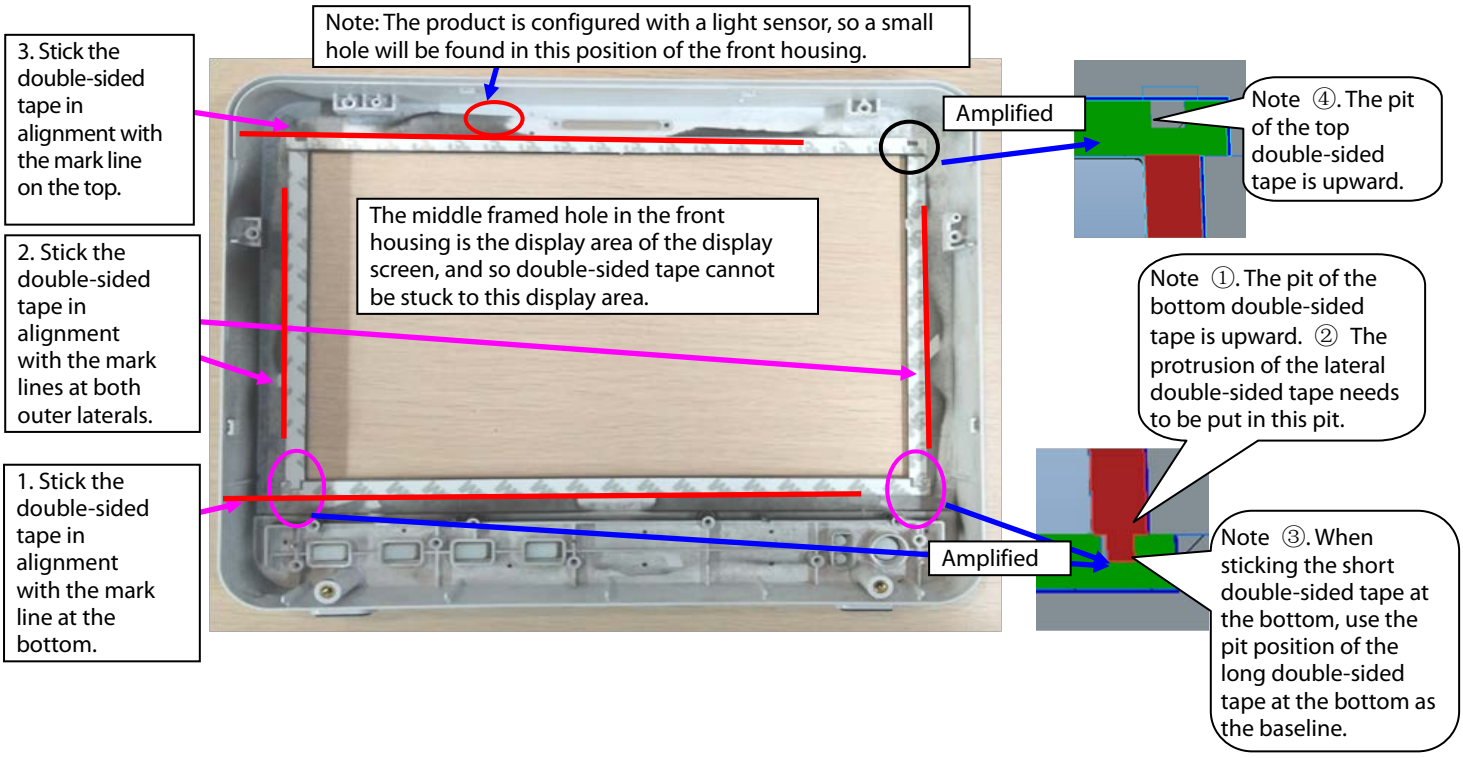


9. Loosen the sticker connecting the touch screen with the front housing, and tilt and take the touch screen out.

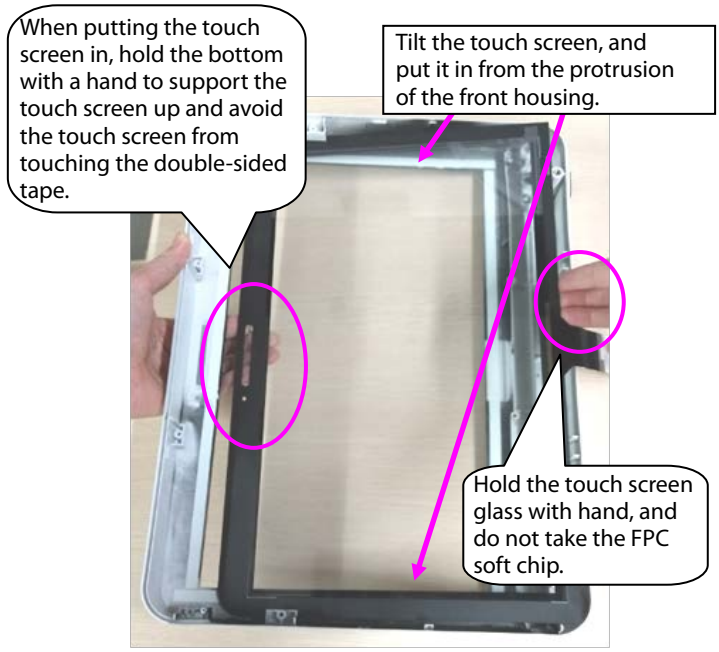




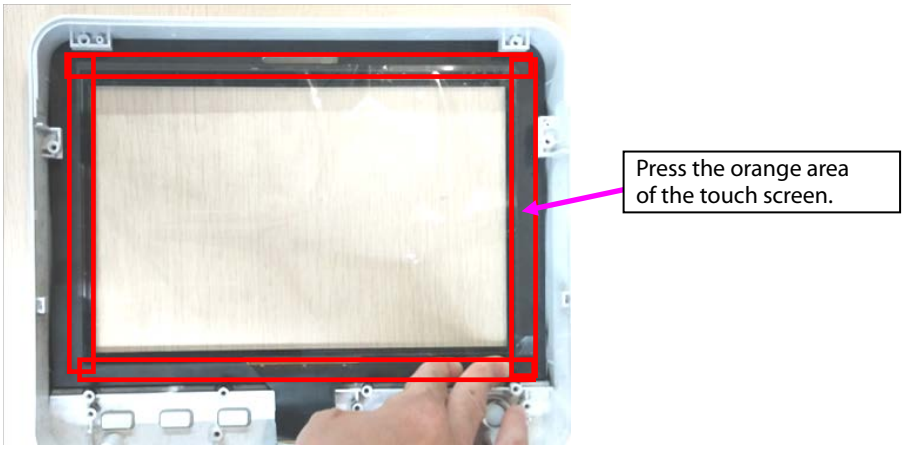
Note 1. During reassembly of the touch screen rubber, follow the requirements below to perform assembly.



Note 2. During reassembly of the touch screen, follow the requirements below to perform assembly.

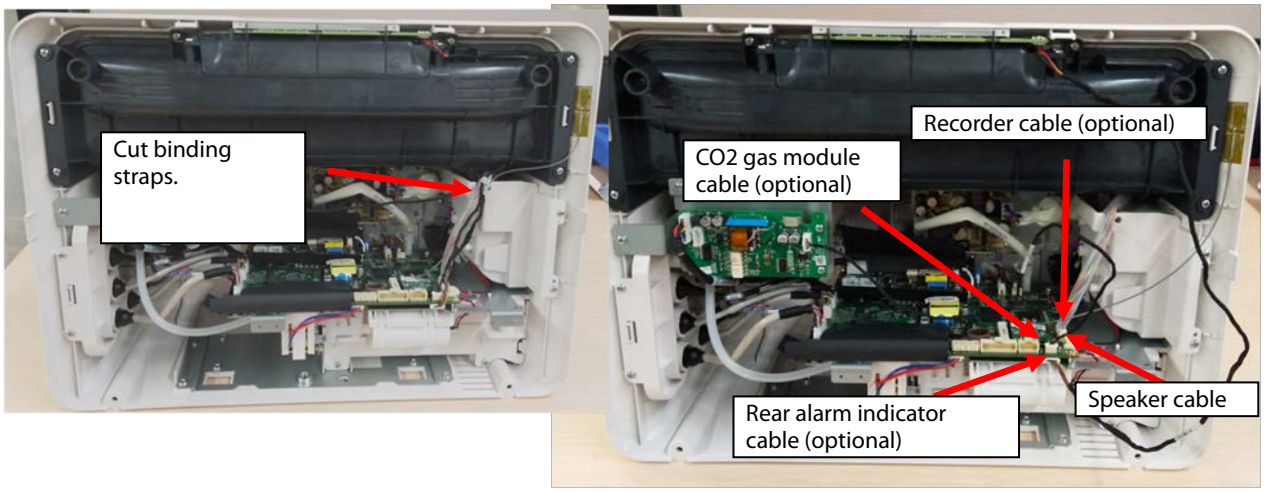


Note 3. After reassembly of the touch screen, follow the requirements below to press the touch screen.

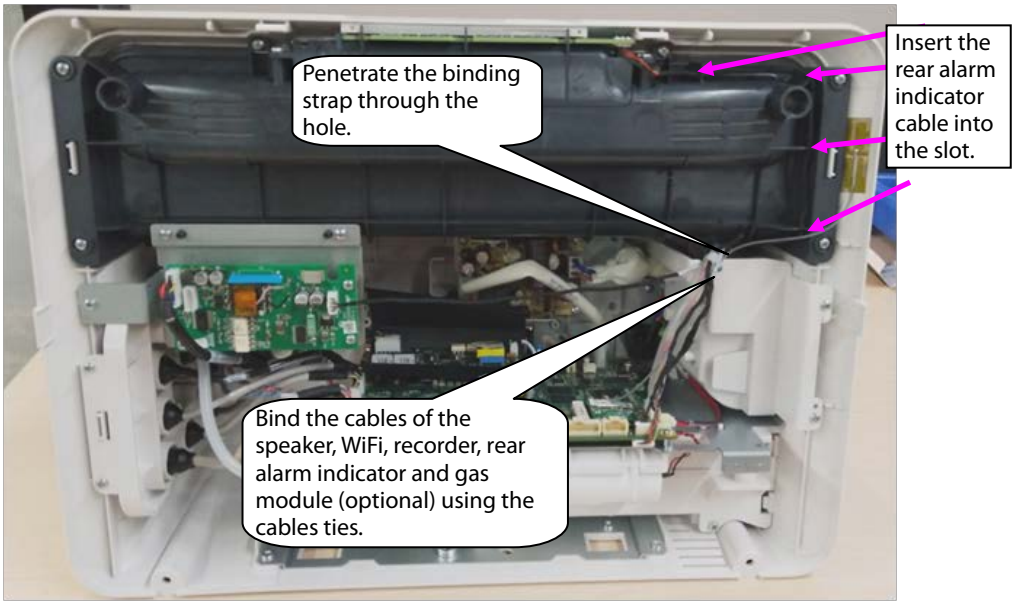


7.3.4 Disassembling WiFi and Parameter Panel

1. Remove cables.



Note. During reassembly, follow the requirements below to perform binding and fixing.

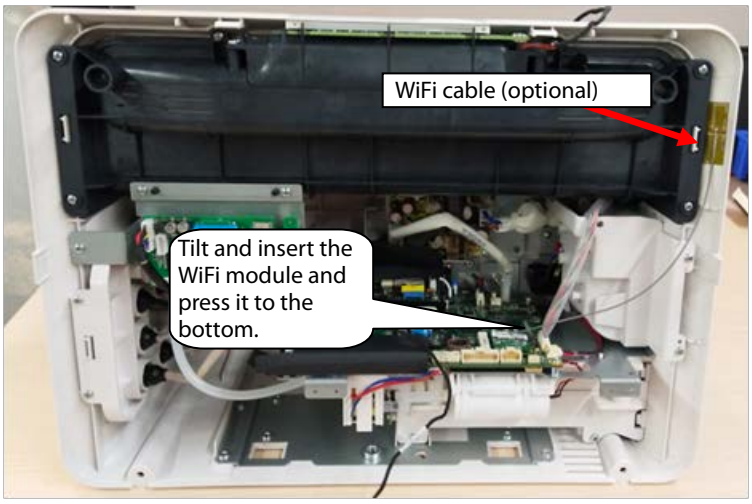


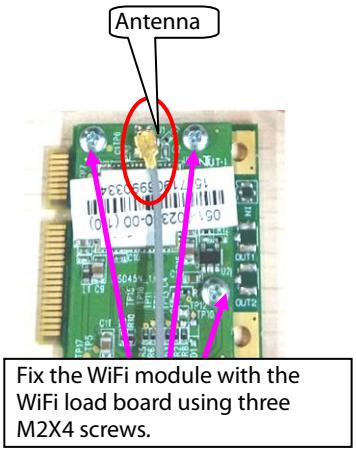
2. When WiFi is configured, disassemble the WiFi module.

A. Take the WiFi module out.

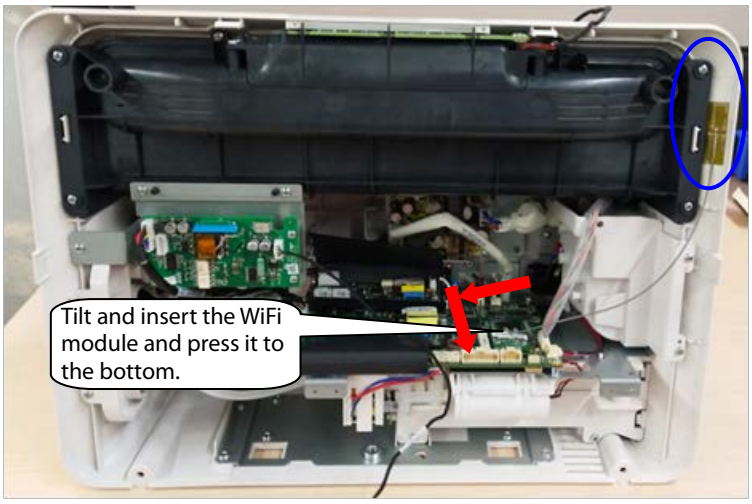
B. Remove the WiFi cable.

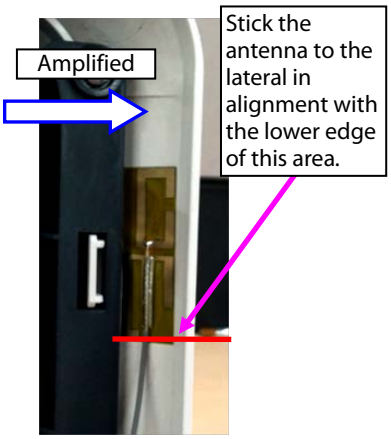
C. Loosen the three M2X4 screws fixing the WiFi module and WiFi load board, and take the WiFi module and WiFi load board out.





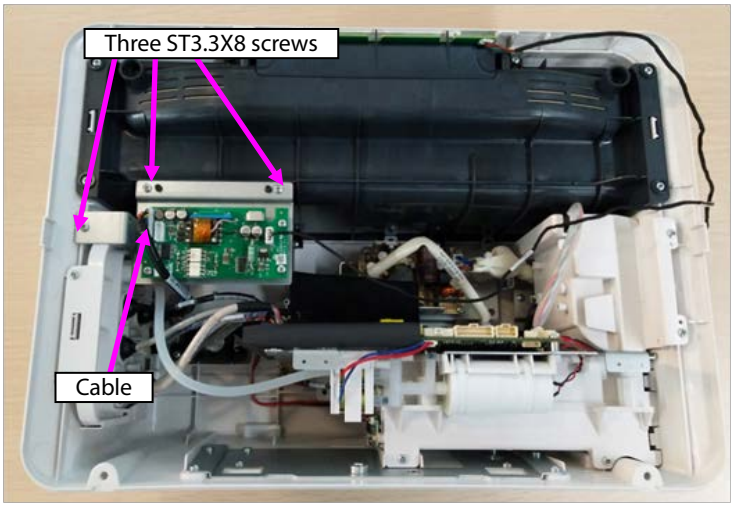
Note. During reassembly of the WiFi module, follow the requirements below to perform assembly.





3. When mainstream CO_2 is configured, disassemble the CO_2 module.

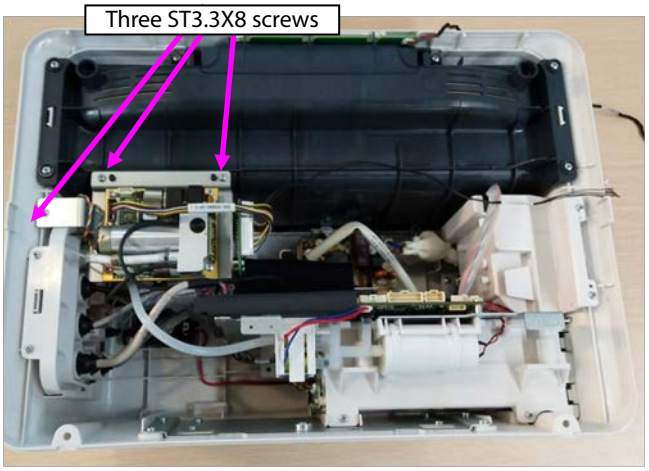
Remove the cables pointed by the arrows in the following figure, loosen three ST3.3X8 cross pan head tapping screws using the screwdriver, and take the module out.



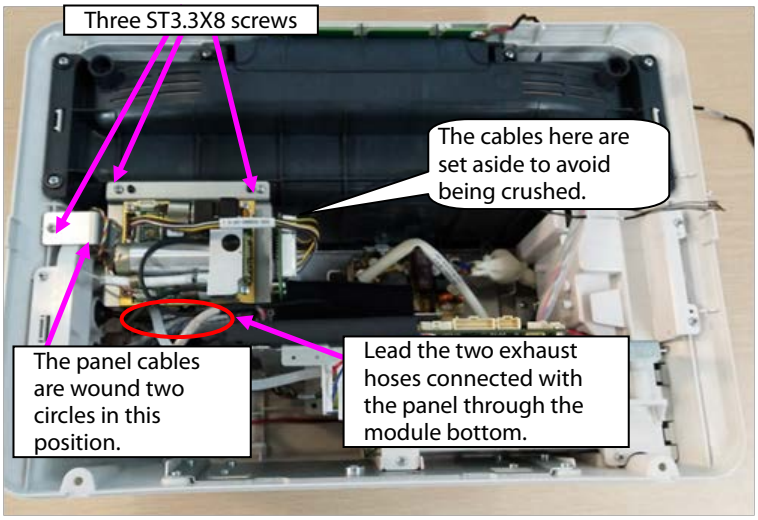
4. When microstream CO_2 is configured, disassemble the CO_2 module.

A. Loosen three ST3.3X8 cross pan head tapping screws using the screwdriver, and take the module out.

B. Remove the connection between the microstream module exhaust hose and panel exhaust hose.

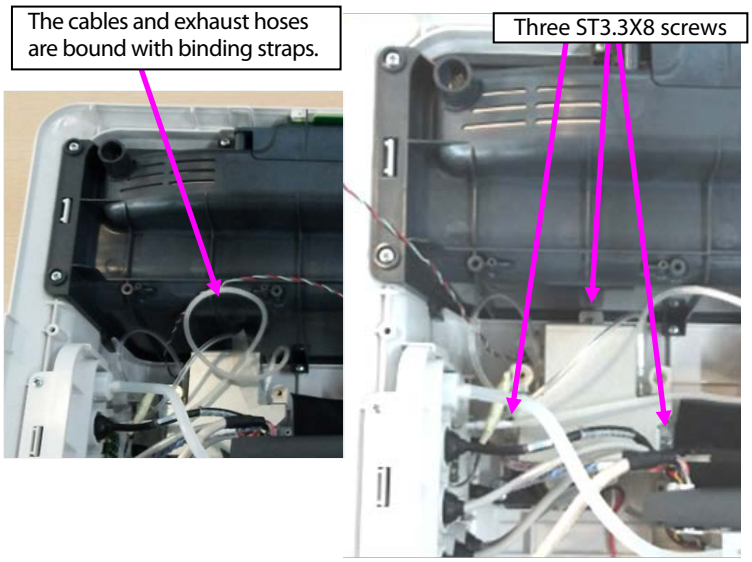


Note. During reassembly of the microstream CO_2 module, follow the requirements below to perform assembly.

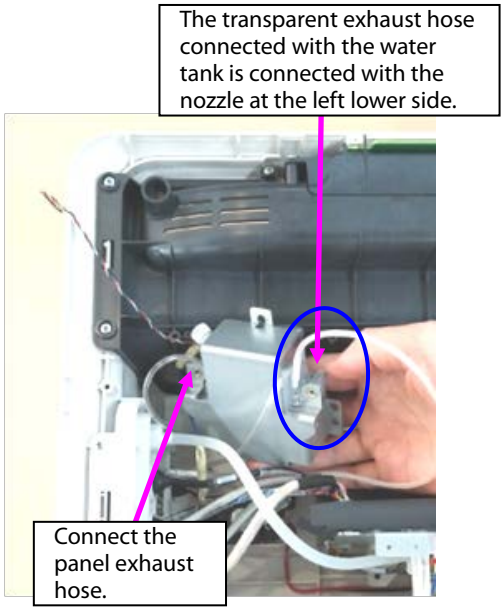


5. When sidestream CO_2 is configured, disassemble the CO_2 module.

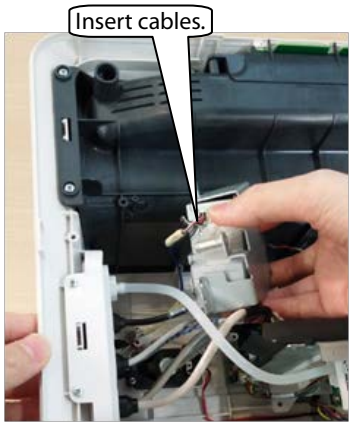
A. Loosen the cable ties shown in the following figure, take the three ST3.3X8 cross pan head tapping screws out, and take the sidestream CO_2 module out.



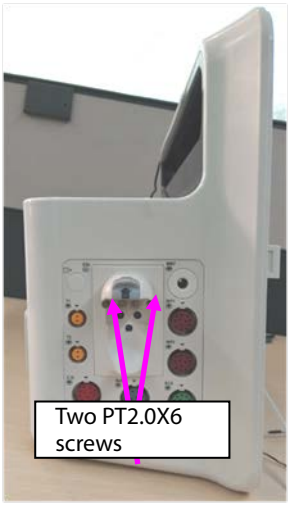
B. Take the exhaust hose connected with the sidestream CO_2 module out.

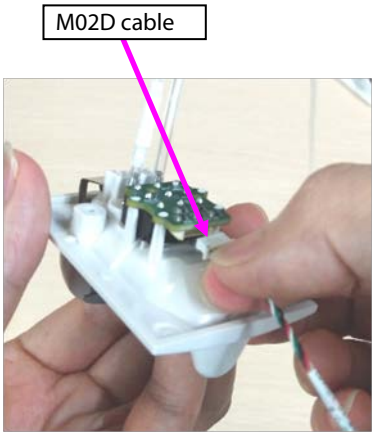


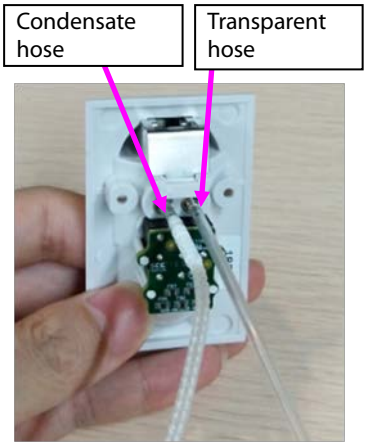
B. Loosen the cable connection, and take the module out.



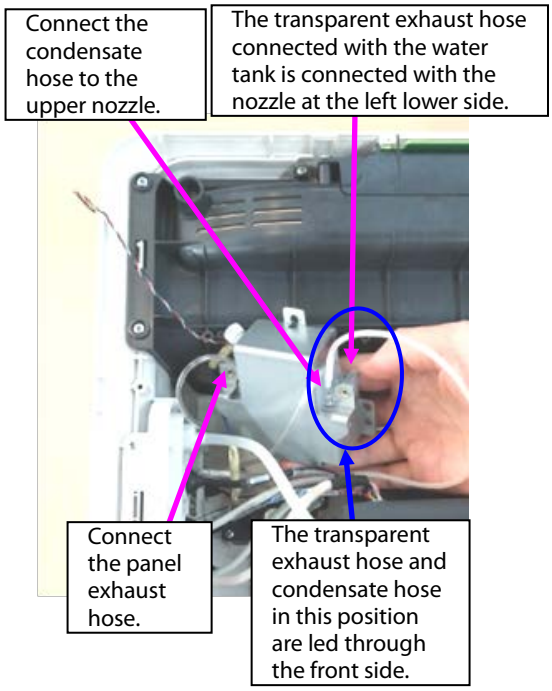
C. Disassemble the two PT2.0X6 screws on the panel water tank, and take the water tank out.

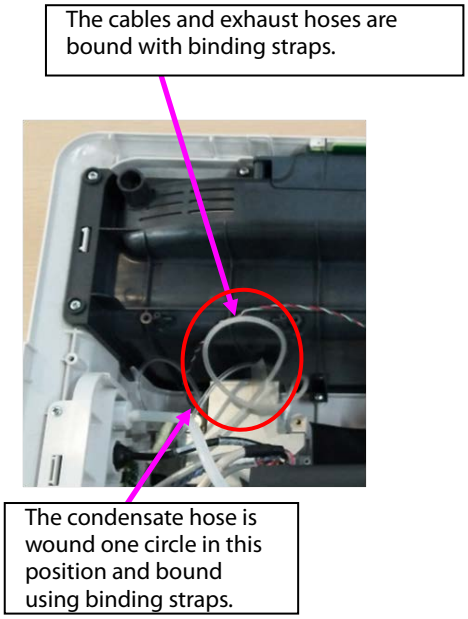




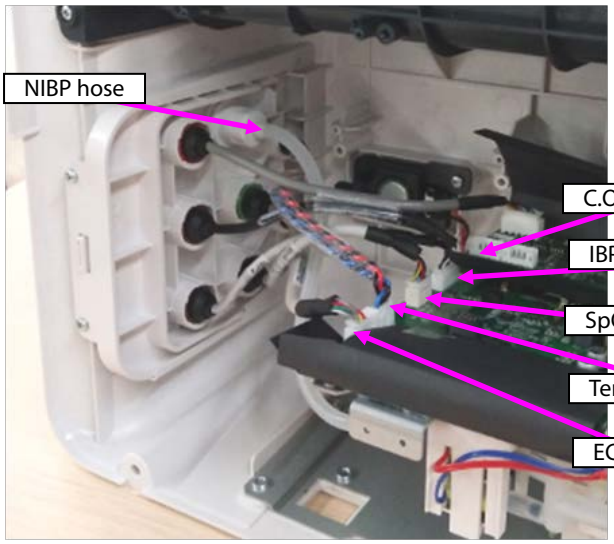


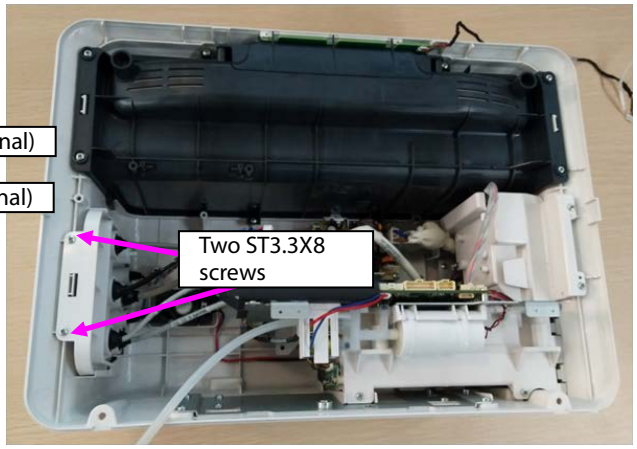
Note. During reassembly of the sidestream CO_2 module, follow the requirements below to perform assembly.





6. Remove the panel cable from the mainboard, and remove the NIBP exhaust hose.
7. Loosen two ST3.3X8 cross pan head tapping screws using the screwdriver, and take the panel fixing pin and panel component out.





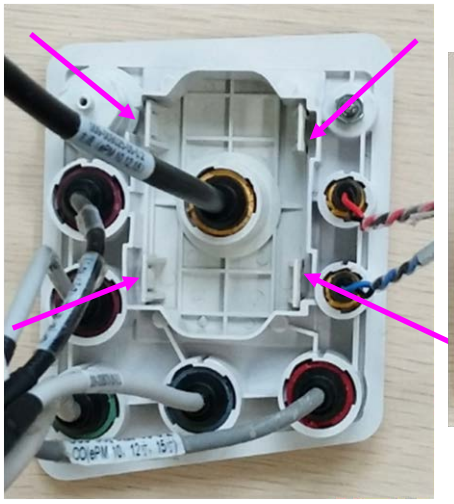
8. When a mainstream module is configured, disassemble the mainstream panel port.

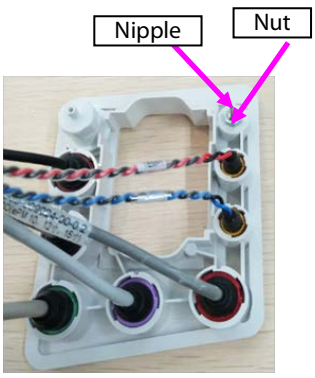
A. Use pliers or tweezers to jack the fastener on the panel, and take the interface board out.

B. Rotate the cable anticlockwise, and remove the CO_2 cable.

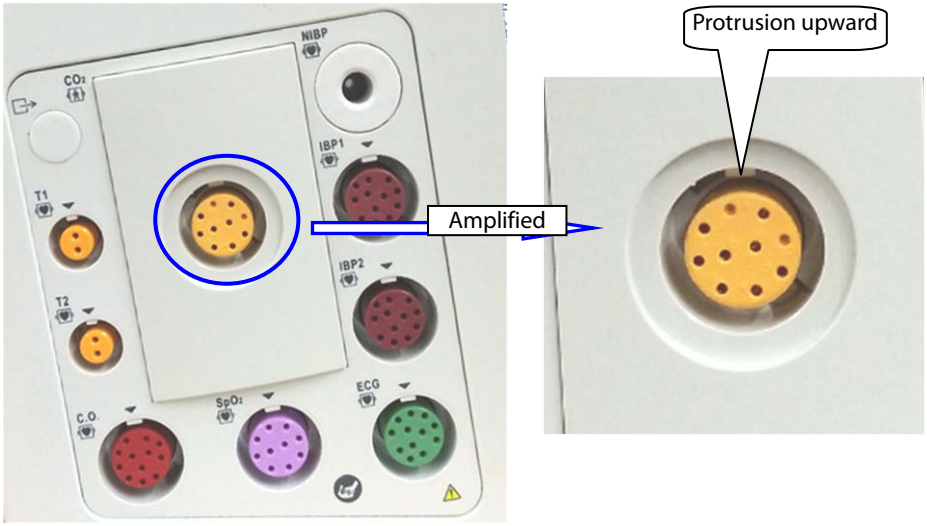
C. Remove the plug from the panel.

D. Loosen the M5 screw from the upper right corner of the panel, and take the nozzle out.

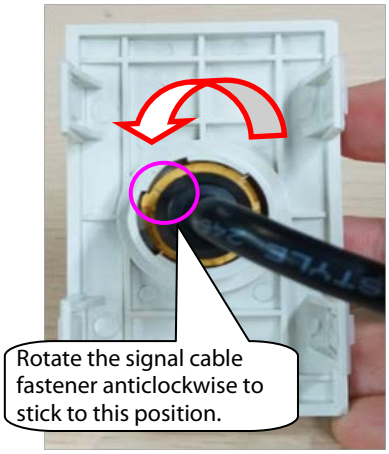




Note 1. During reassembly, the interface board of the mainstream panel should be in the following direction.



Note 2. During reassembly of the cable to the interface board, tighten it firmly anticlockwise.

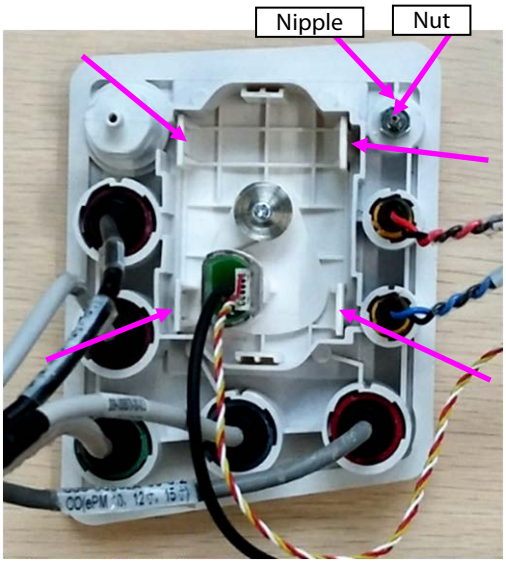


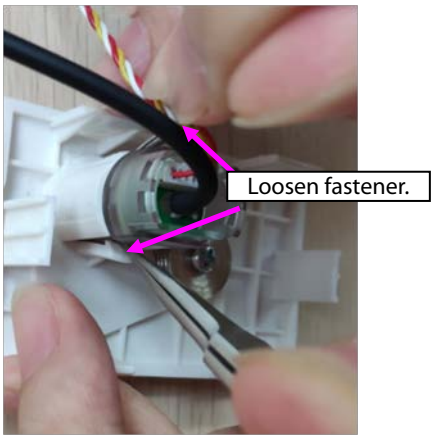
9. When an microstream module is configured, disassemble the microstream water tank.

A. Use pliers or tweezers to jack the fastener on the panel, and take the microstream water tank base out.

B. Loosen the M5 screw from the upper right corner of the panel, and take the exhaust nozzle out.

C. Use tweezers to loosen the fastener on the water tank base, and take the microstream connector out.





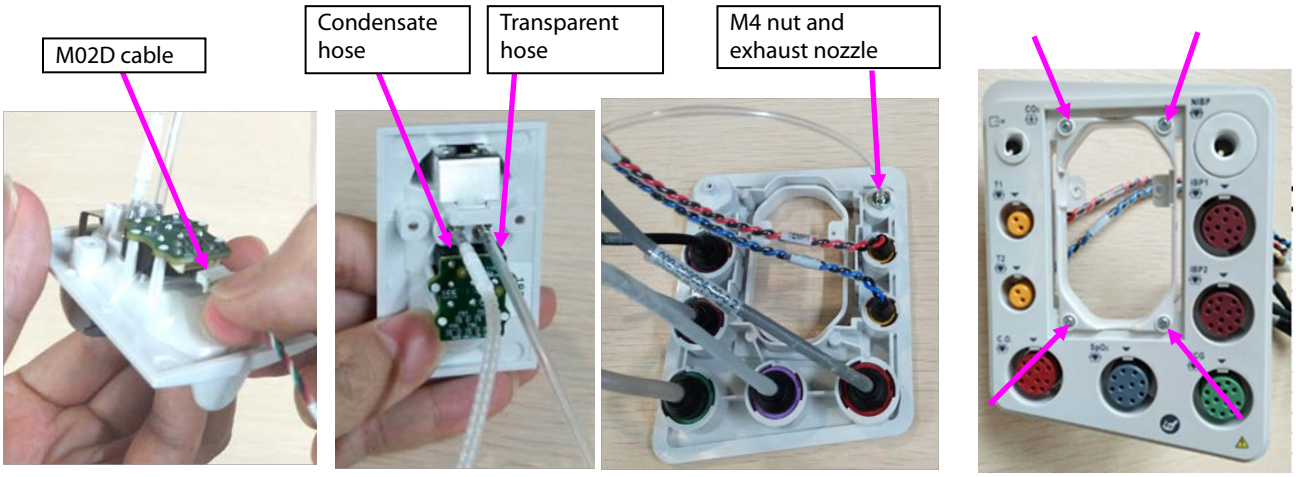
10. When a sidestream module is configured, disassemble the sidestream water tank.

A. Remove the cable or hose from the water tank.

B. Remove the exhaust hose from the panel, loosen the M4 screw on the exhaust nozzle, and take the nozzle out.

C. Loosen the M5 screw/M4 nut on the panel, and take the exhaust nozzle out.

D. Loosen the four PT2.0X6 screws on the panel, and take the bracket of the sidestream water tank out.



11. Disassemble the panel cable.

A. According to the figure, rotate different parameter cables anticlockwise, and remove them.

B. Take the arrival reminding shrapnel out.

Diagram (CO2 gas module is not used)

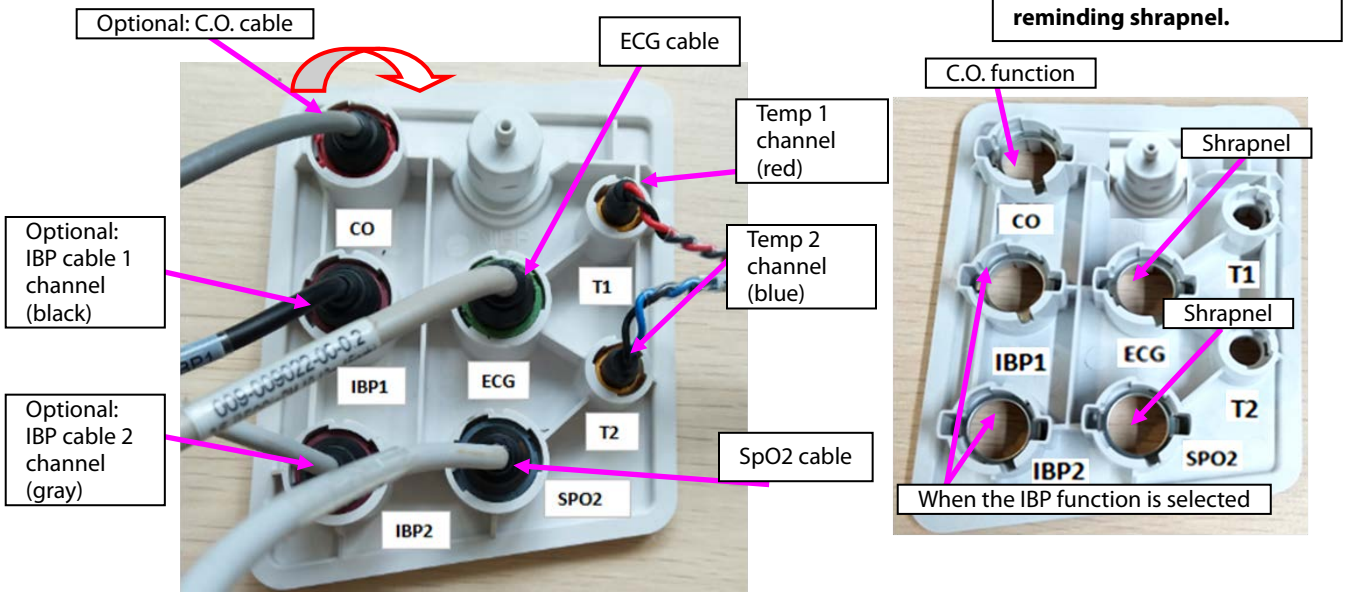
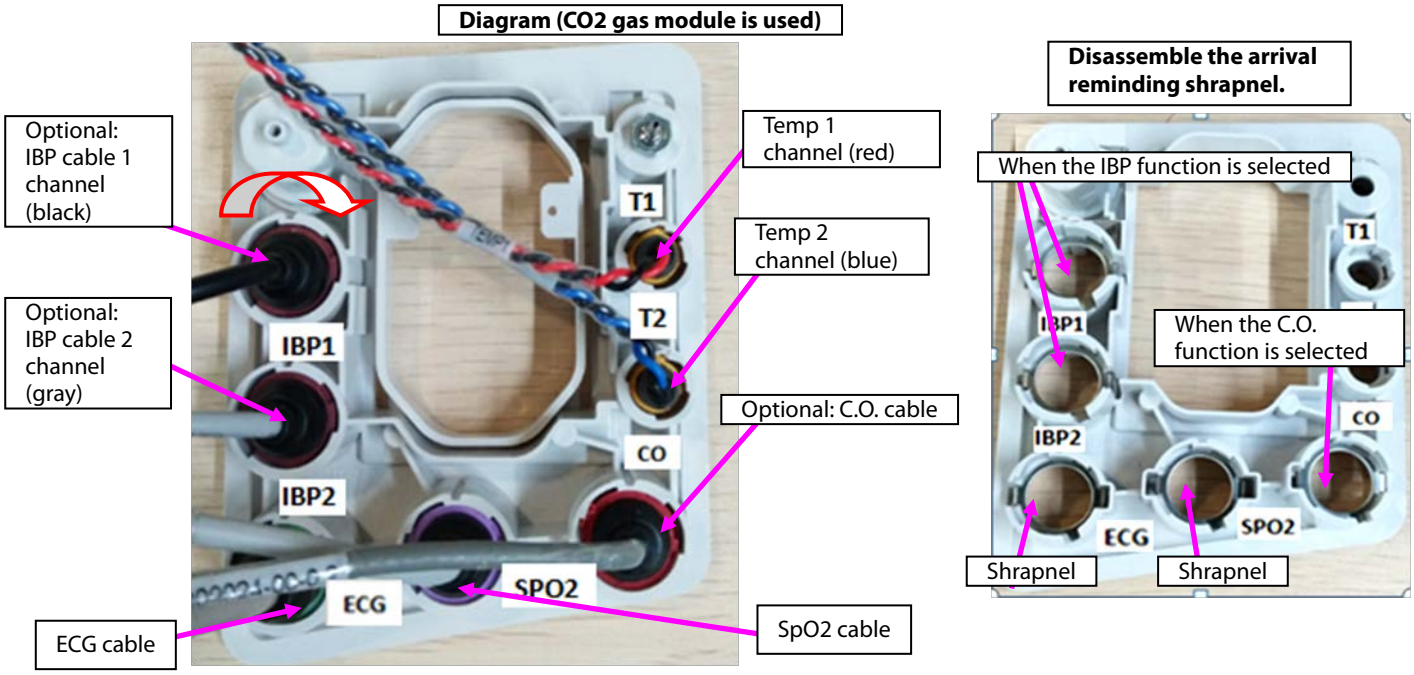
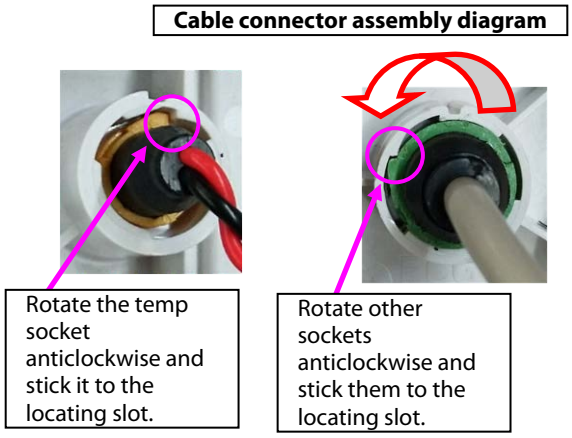


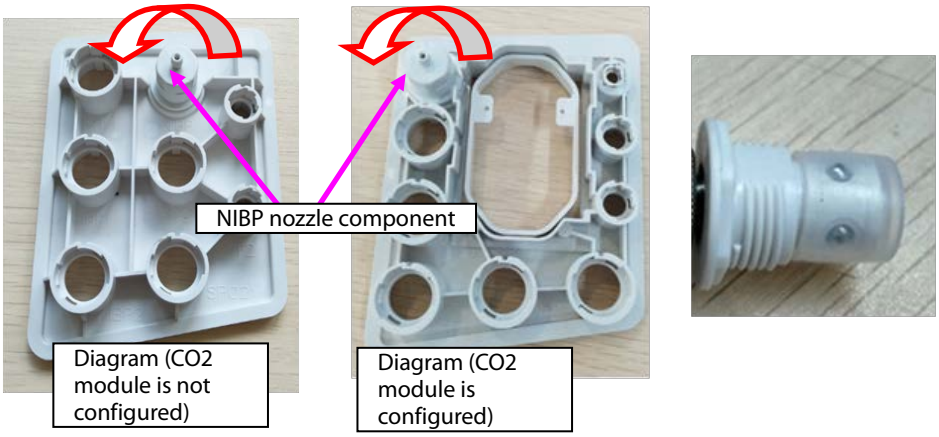
Diagram (CO2 gas module is used)



Note. During reassembly, follow the requirements below to perform cable assembling.



12. Disassemble the NIBP nozzle: Rotate the NIBP nozzle anticlockwise, and disassemble the NIBP nozzle.

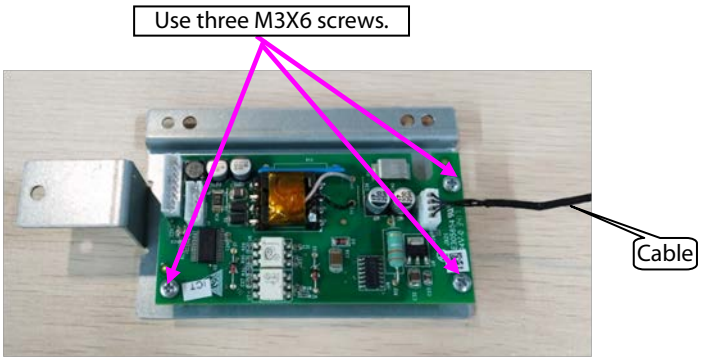


7.3.5 Disassembling Gas Module

1. When mainstream CO_2 is configured:

A. Loosen the three M3X6 screws in the figure, and take the mainstream CO_2 isolation power board out.

B. Remove the cable connecting the mainstream isolation power board with the mainboard.



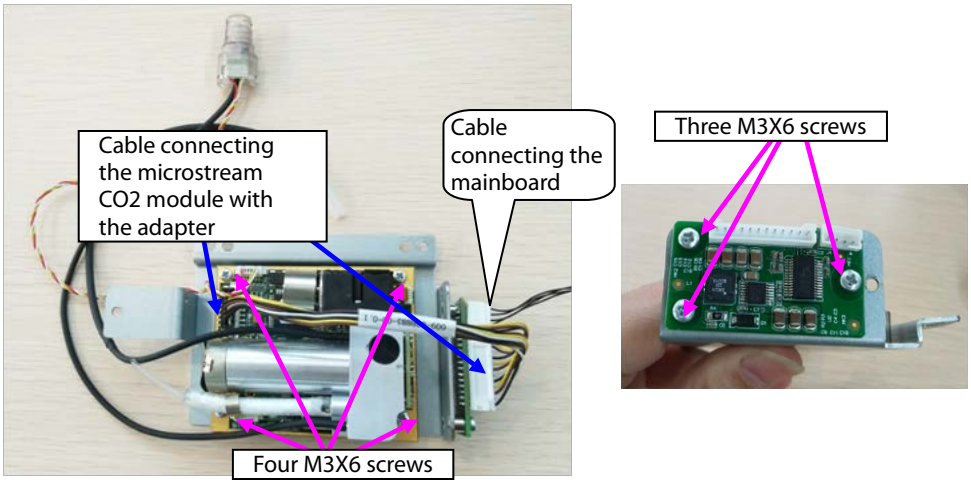
2. When microstream CO_2 is configured:

A. Remove the cable connecting the microstream CO_2 module with the adapter.

B. Remove the cable connecting the mainboard.

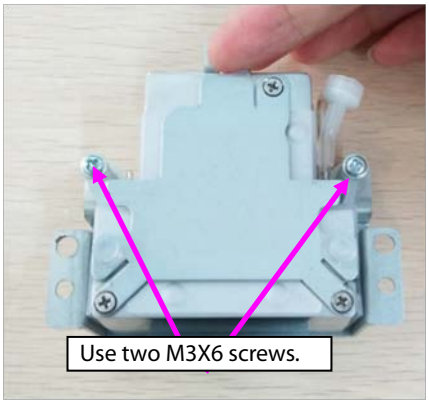
C. Loosen the four M3X6 screws in the figure, and take the microstream CO_2 module out.

D. Loosen the three M3X6 screws, and take the adapter out.



3. When sidestream CO_2 is configured:

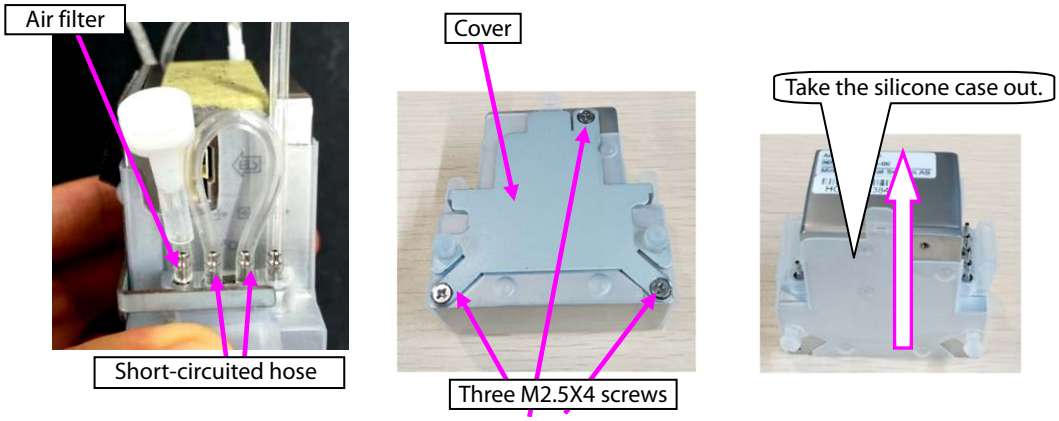
A. Loosen the two M3X6 screws in the figure, and take the sidestream gas module out.



B. Take the air filter and short-circuited hose out.

C. Loosen the three M2.5X4 countersunk screws, and take the cover out.

D. Take the silicone case out.

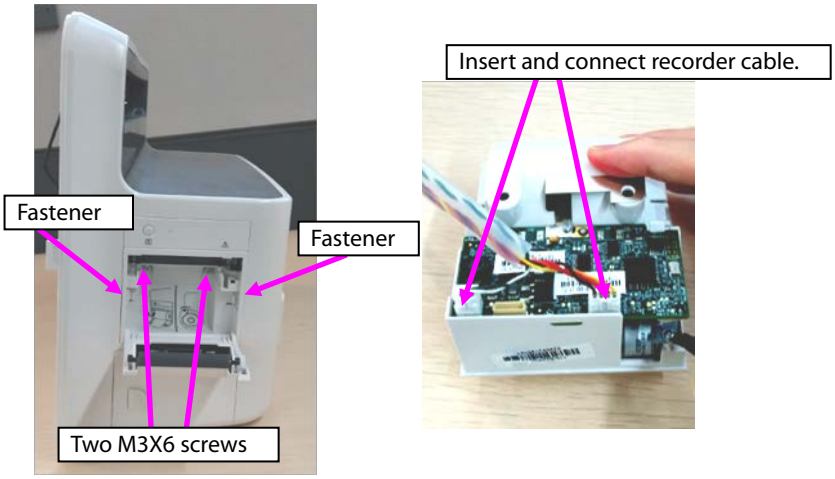


7.3.6 Disassembling Recorder/Recorder Bracket

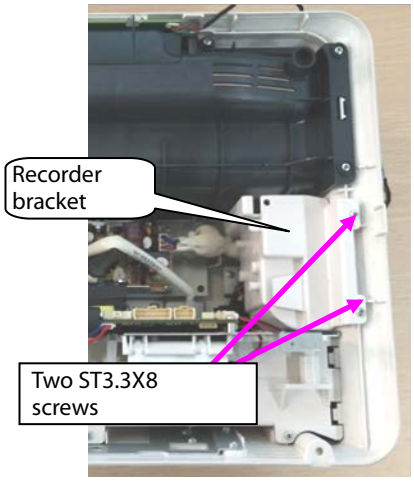
1. When the recorder is configured, disassemble the recorder:

A. Loosen the two M3X6 screws of the recorder, loosen the two fasteners of the recorder, and take the recorder out.

B. Remove the cable connecting the two sockets of the recorder.

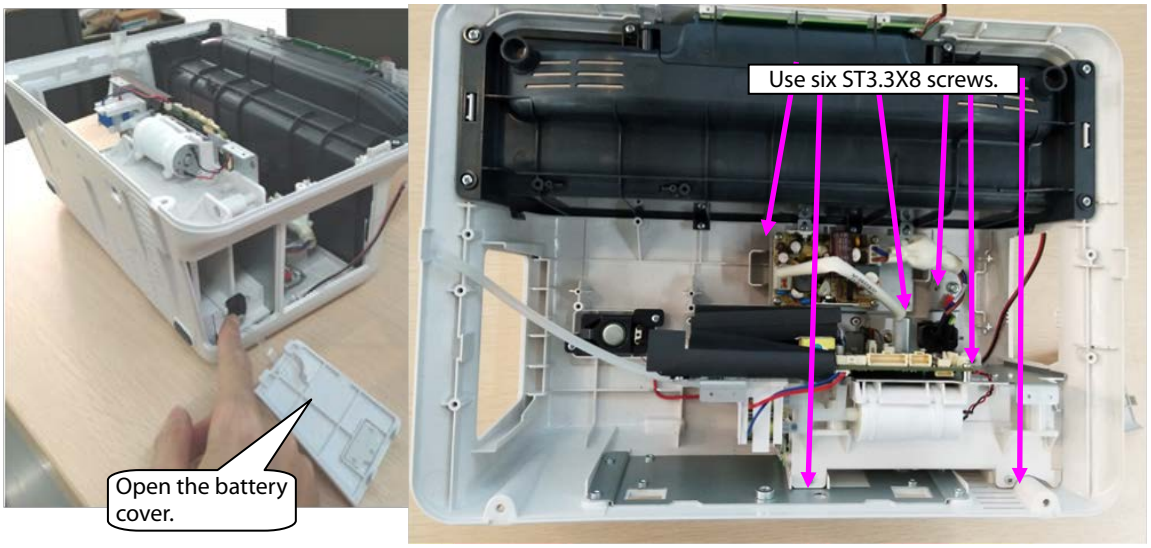


2. Take the recorder bracket out: Loosen the two ST3.3X8 screws on the recorder bracket, and take the recorder bracket out.

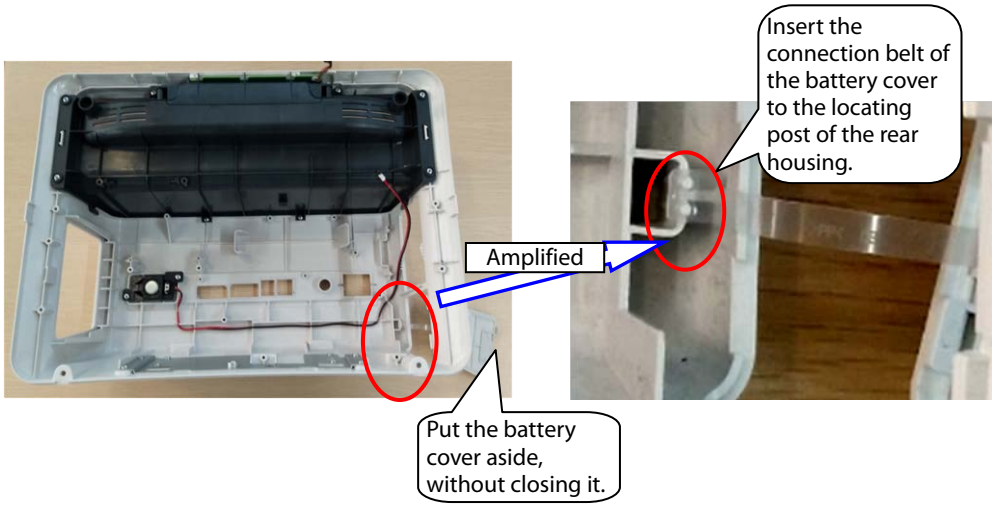


7.3.7 Disassembling Main Bracket Component

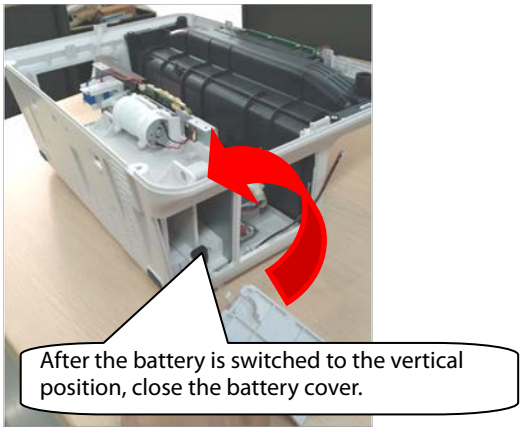
1. Loosen the battery cover.
2. Loosen the five ST3.3X8 screws shown in the figure, and remove the main bracket component.



Note 1. Before reassembling the main bracket component, insert the connection belt of the battery cover to the locating post of the rear housing shown in the following figure.

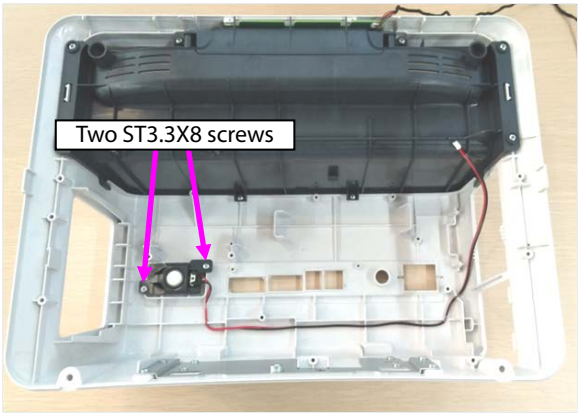


Note 2. Before closing the battery cover, switch the battery to the vertical position shown in the figure.

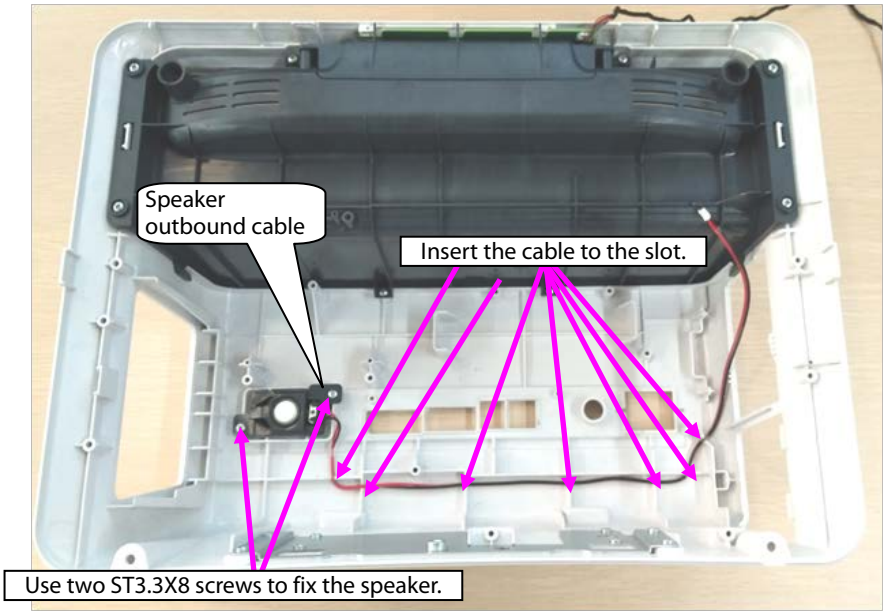


7.3.8 Disassembling Speaker

1. Loosen the two ST3.3X8 screws of the speaker component shown in the figure, and take the speaker component out.



Note. During reassembly of the speaker, follow the requirements below to perform assembly.

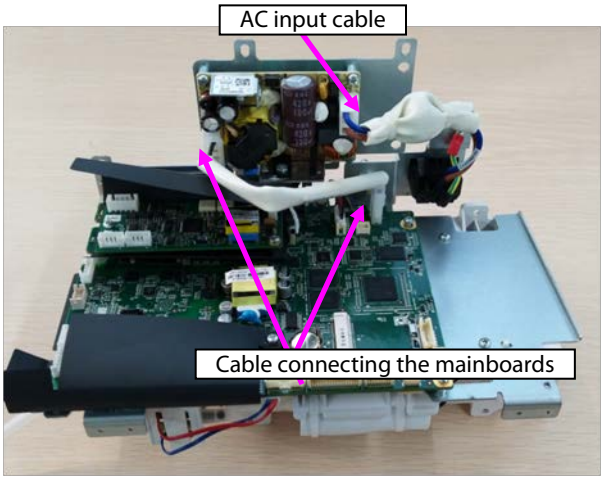


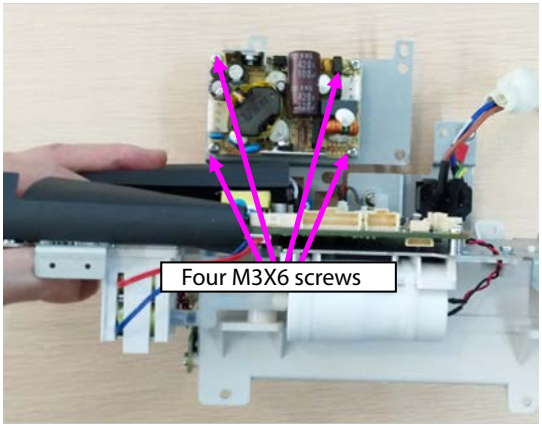
7.3.9 Disassembling Rear Alarm Indicator (Configured)

1. Loosen the eight ST3.3X8 screws on the cover component shown in the figure, and take the top cover component out.
2. Loosen the one ST3.3X8 screw on the rear alarm indicator shown in the figure, and take the rear alarm indicator component out.

7.3.10 Disassembling Power Module

1. Remove the AC input cable, and remove the cable connecting the power module with mainboard out.
2. Loosen the four M3X6 screws of the power module, and take the power module out.

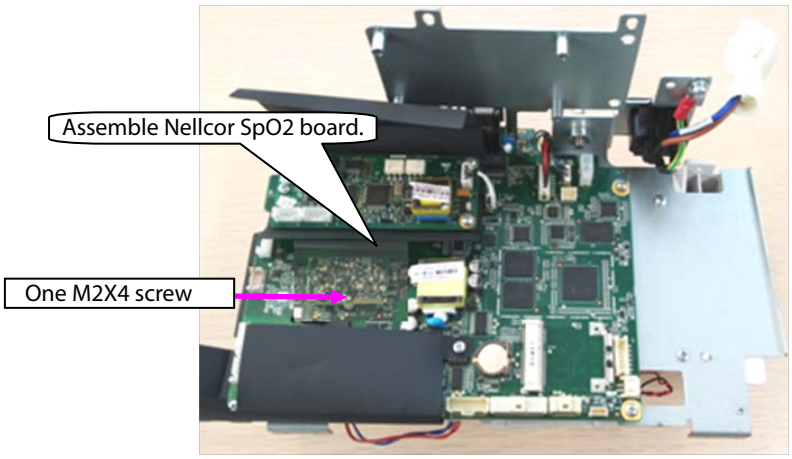




7.3.11 Disassembling SpO_2 Module (When Nellcor/Massimo SpO_2 Is Configured)

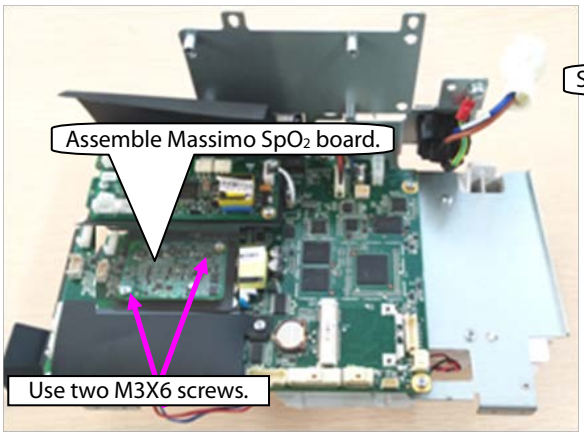
1. When Nellcor SpO_2 is configured:

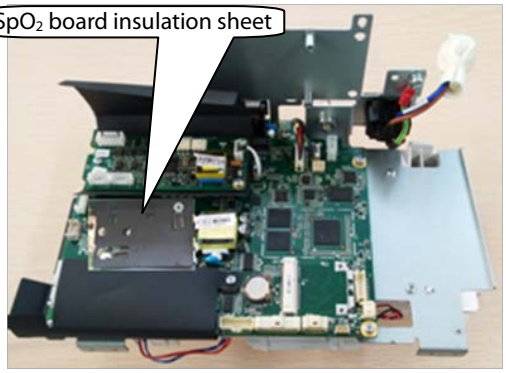
Loosen the one M2X4 screw on the Nellcor SpO_2, and take the Nellcor SpO_2 board out.



2. When Massimo SpO_2 is configured:

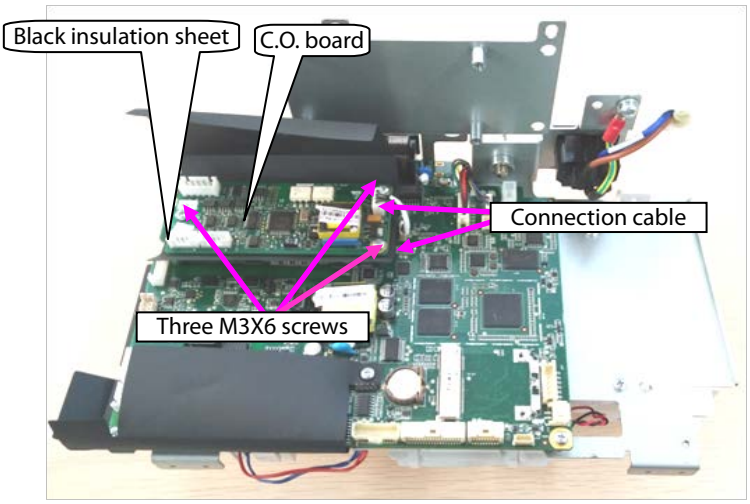
Loosen the two M2X4 screws on the Massimo SpO_2, and take the Massimo SpO_2 board and insulation sheet out.





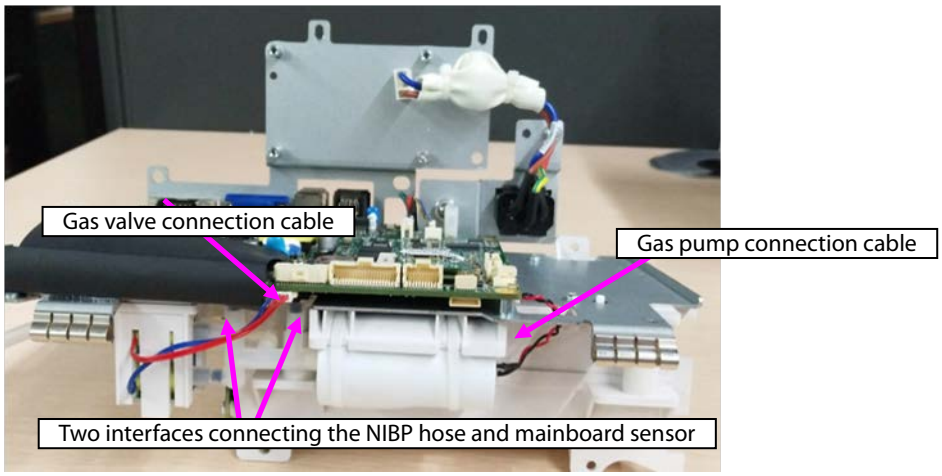
7.3.12 Disassembling C.O. Board (Configured)

1. Remove the cable connecting the C.O. board with the mainboard.
2. Loosen the two M3X6 screws on the Massimo SpO_2, and take the C.O. board and insulation sheet out.

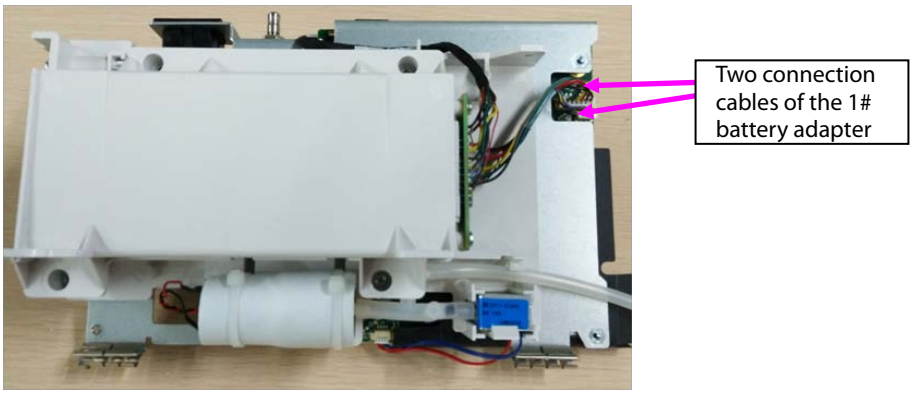


7.3.13 Disassembling Mainboard

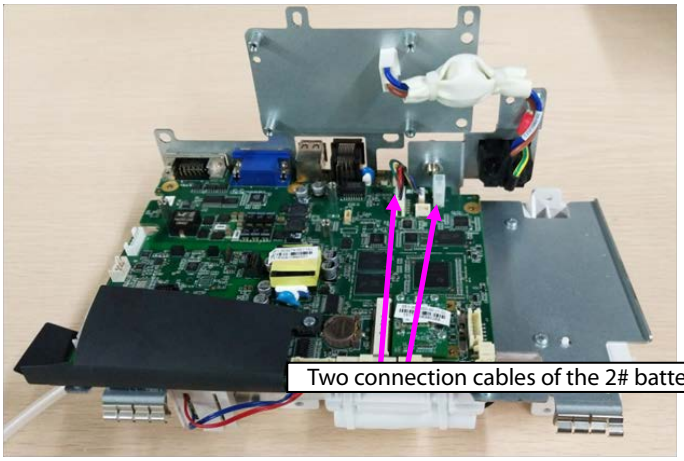
1. Remove the pump/valve connection cables from the mainboard.
2. Take the two interfaces of the NIBP hose from the mainboard sensor.



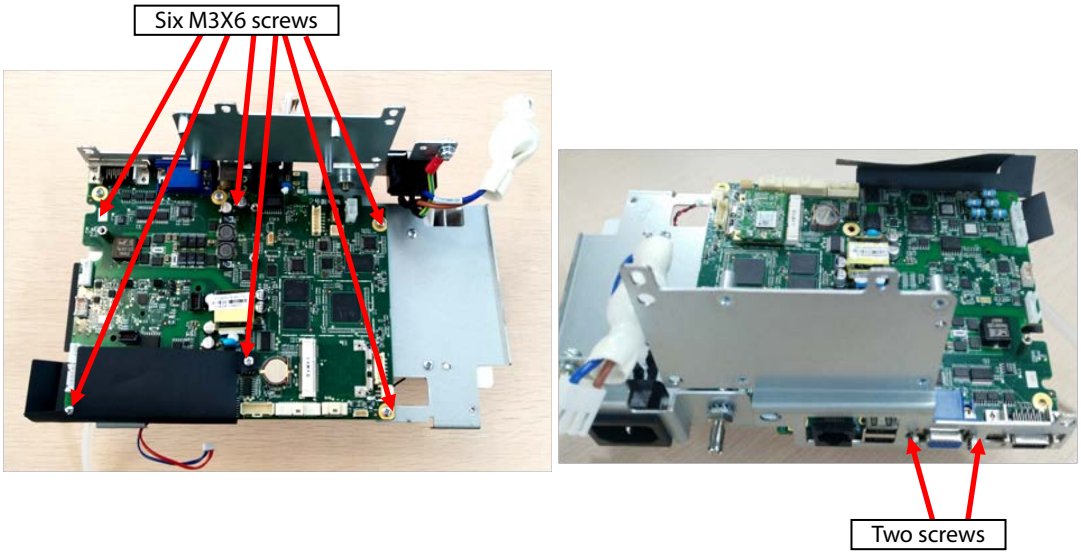
3. Remove the connection cable of the battery adapter from the mainboard.



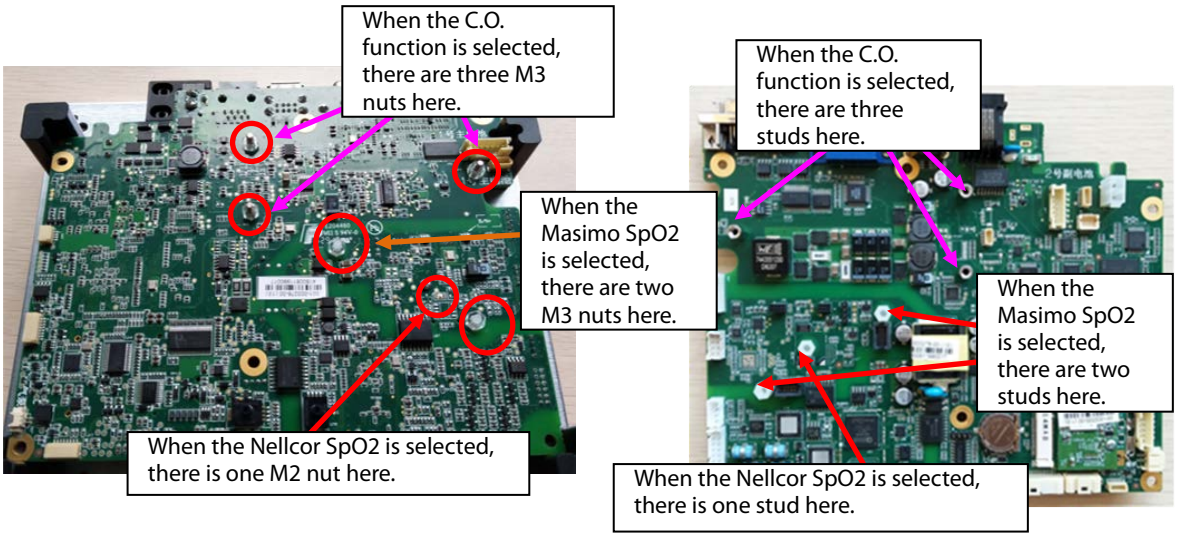
4. When two batteries are configured, remove the connection cable of the 2# battery adapter from the mainboard in the figure.



5. Loosen the six M3X6 screws from the main bracket in the figure.
6. Loosen the two screws on the rear of the main bracket sheet metal, and take the mainboard out.

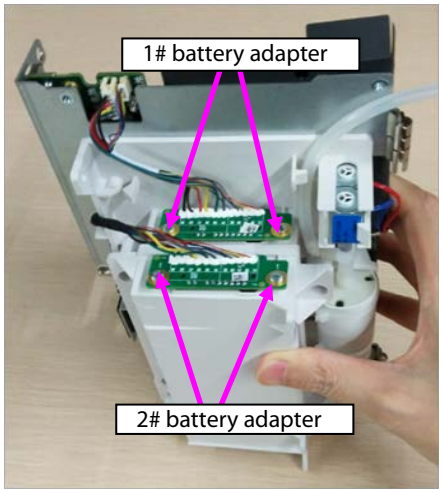


7. As shown in the following figure, loosen the nuts or screws on the rear of the mainboard, and take the studs out.

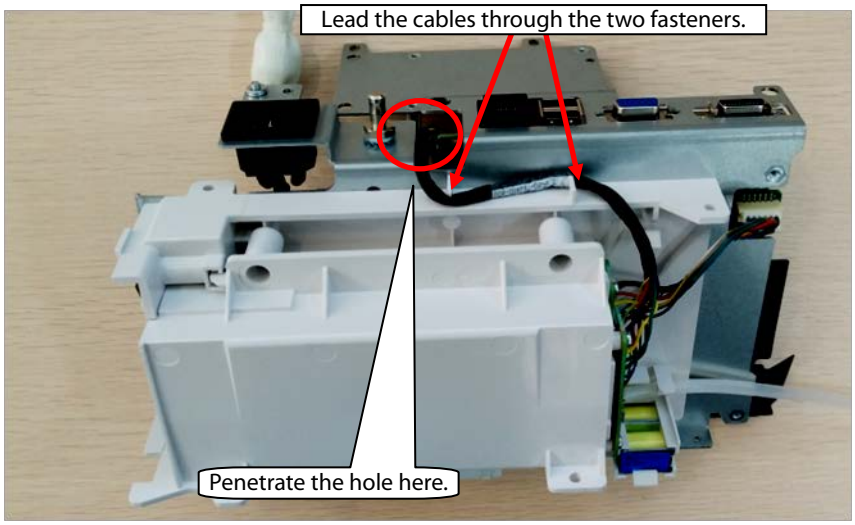


7.3.14 Disassembling Power Adapter and NIBP Pump/Valve

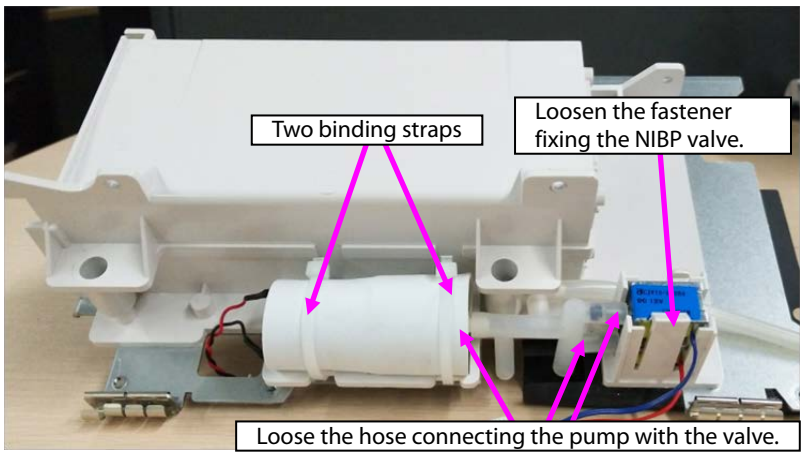
1. As shown in the following figure, loosen the two ST3.3X8 screws, and take the 1# battery adapter out.
2. When 2# battery adapter is configured, loosen the two ST3.3X8 screws, and take the 2# battery adapter out.



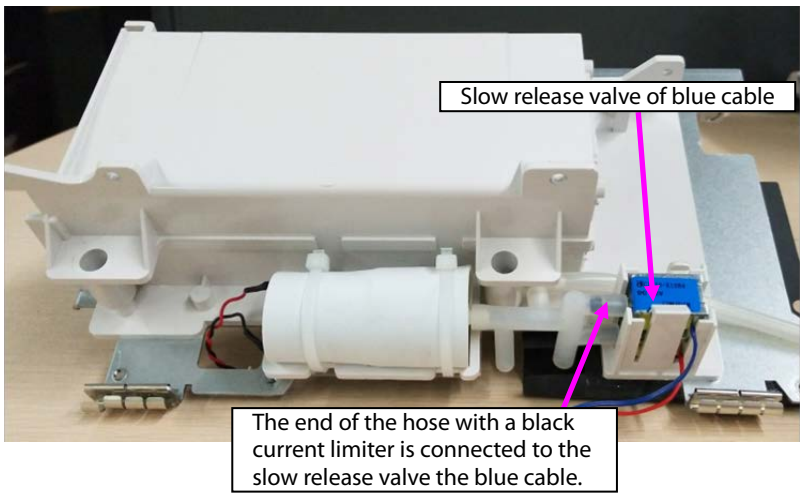
Note. During reassembly of 2# battery adapter, follow the requirements below to perform cable assembly.



3. Loosen the hose connecting the NIBP pump/valve.
4. Loosen the fastener fixing the NIBP valve, and take the NIBP valve out.
5. Loosen the two binding straps fixing the NIBP pump, and take the NIBP pump out.



Note: During reassembly, ensure that the hose is correctly connected with the quick/slow release valve.



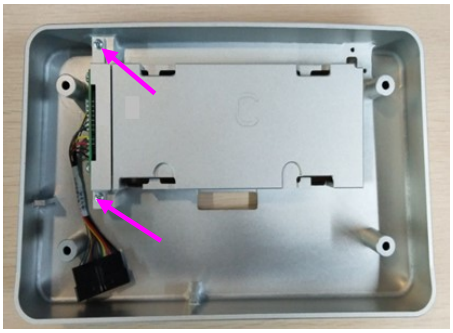
7.4 ePM 12/ePM 12A/ePM 12C Host Disassembly

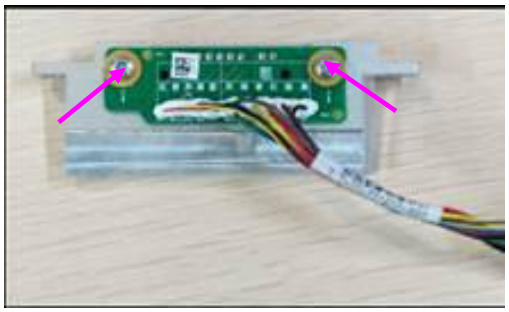
7.4.1 Disassembling Battery Box (Configured)

1. As shown in the following figure, use a Phillips screwdriver to loosen four M3X6 screws, and separate the battery adapter cable from the extension cable.

2. Remove the battery box component.
3. Pull the connection belt of the battery cover outward to open the battery cover, and put the screwdriver near the shaft of the battery cover to level the battery cover, and take the battery cover out.

4. Use the Phillips screwdriver to loosen two M3X6 screws, take the bracket fixing the battery adapter out, use the Phillips screwdriver to loosen two M3X6 screws, and take the battery adapter out.

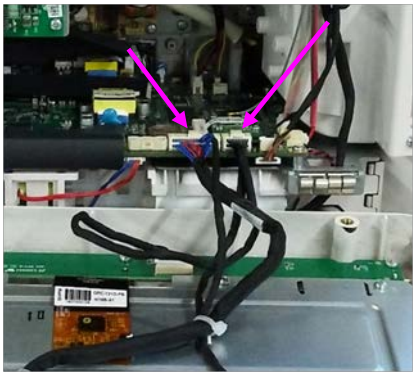




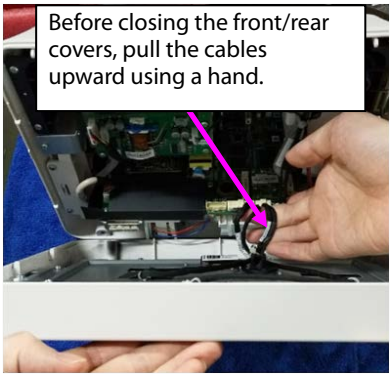
7.4.2 Disassembling Front/rear Housing Components of Host

1. Use a long Phillips screwdriver to loosen four M4X8 screws.

2. Open the front/rear housings, and remove the display screen connection cable and keypad connection cable.

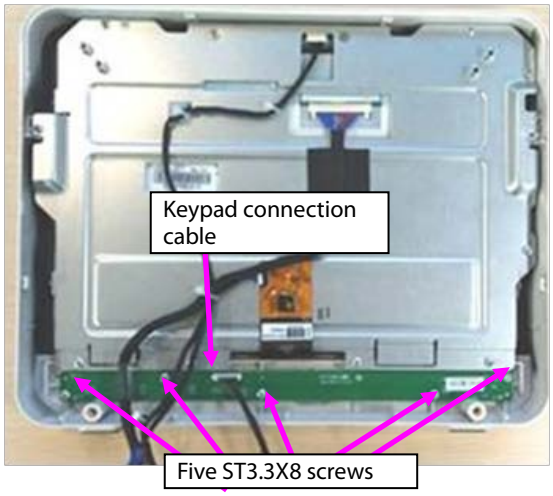


Note: During reassembly, close the front/rear covers and pull the cables upward using a hand.



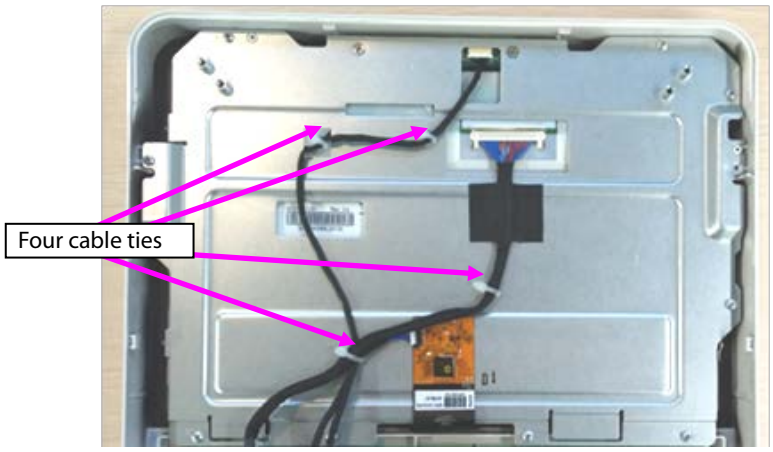
7.4.3 Disassembling Front Housing Component

1. Remove the cable connecting the keypad.
2. Loosen the five ST3.3X8 screws shown in the figure, and take the keypad out.

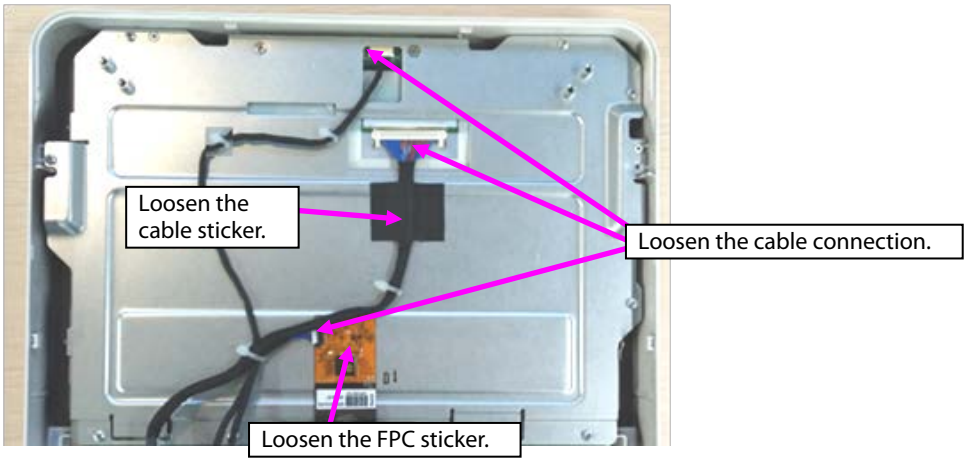


7.4.4 Disassembling Display Screen and Alarm Indicator

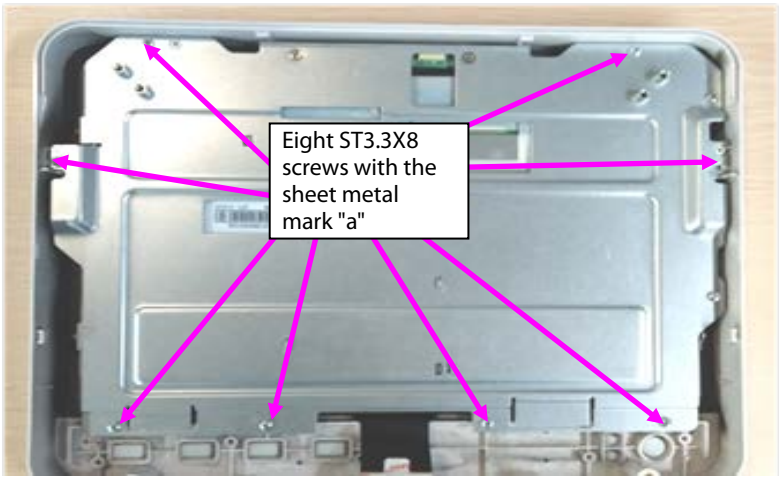
1. Remove the four cable ties from the cables.



2. Remove the cables connecting with the touch screen, display screen, and alarm indicator.
3. Loosen the sticker connecting the touch screen PFC with the sheet metal and the cable stuck to the sheet metal.

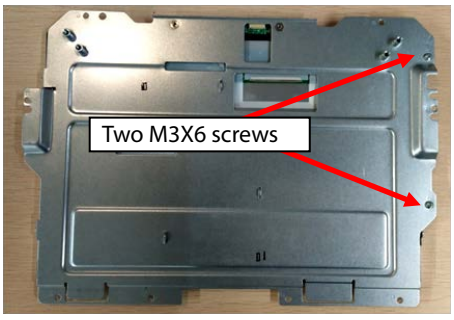


4. Loosen the eight ST3.3X8 screws shown in the figure, and remove the display screen component.

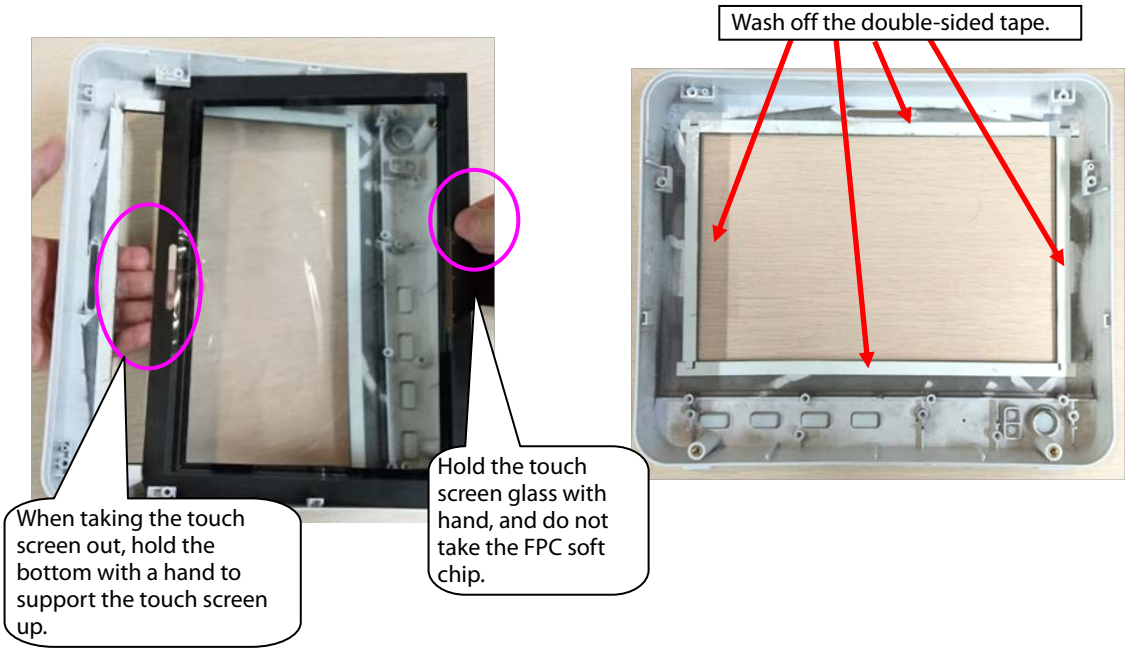


5. Loosen the two M3X6 screws, and take the alarm indicator board out.

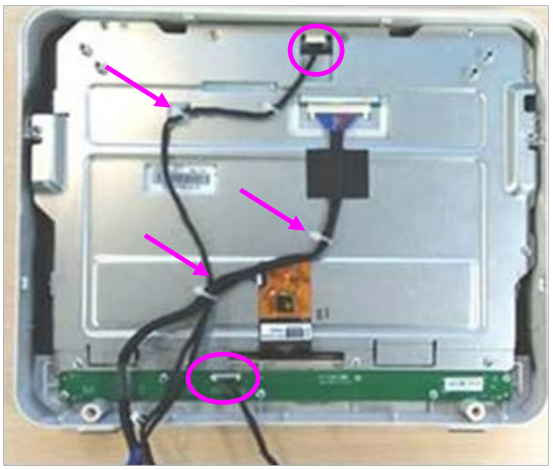
6. Loosen the two M3X6 screws with the mark "b" on the right top of the sheet metal.
7. Loosen the two M2X4 screws at the left side of the sheet metal.
8. Loosen the two M2X4 screws at the left side of the sheet metal, and take the display screen out.



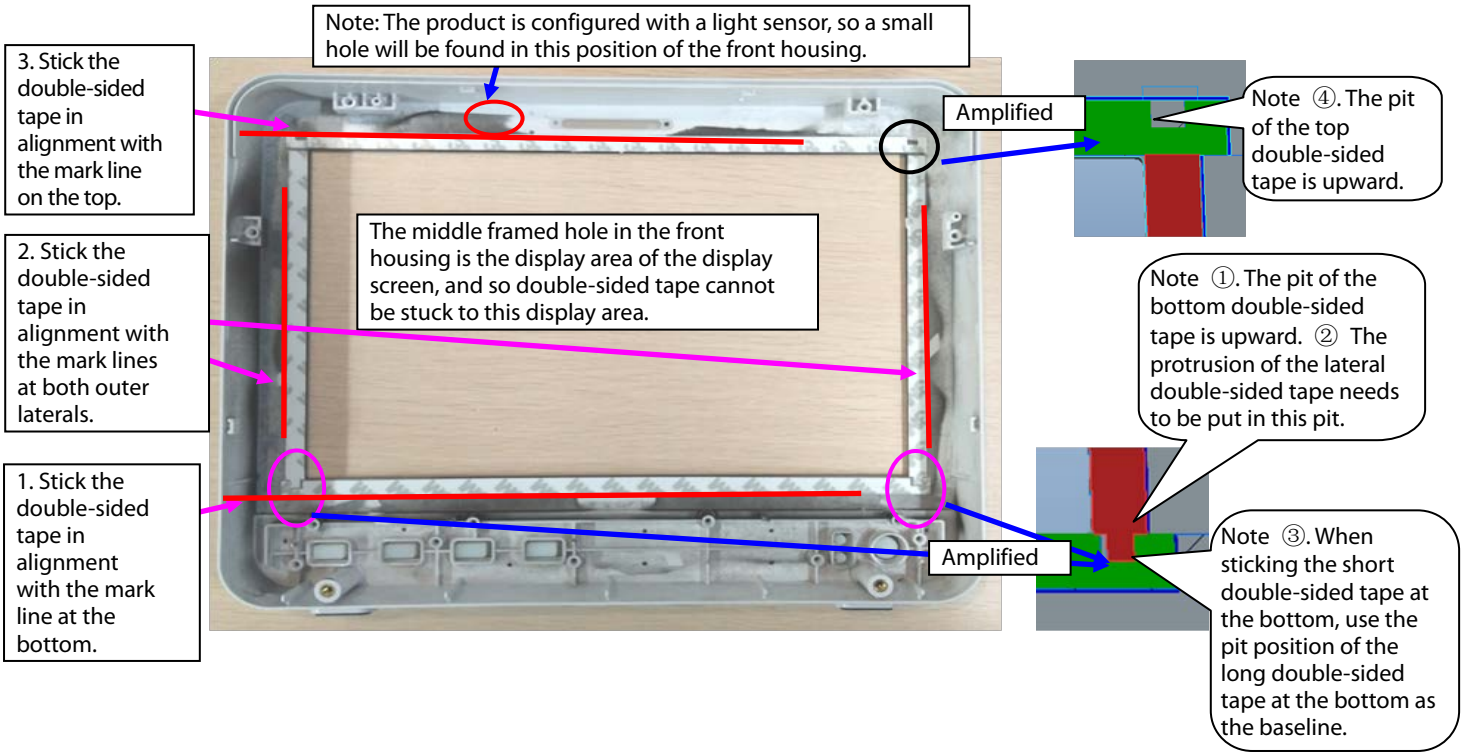
9. Loosen the sticker connecting the touch screen with the front housing, and tilt and take the touch screen out.



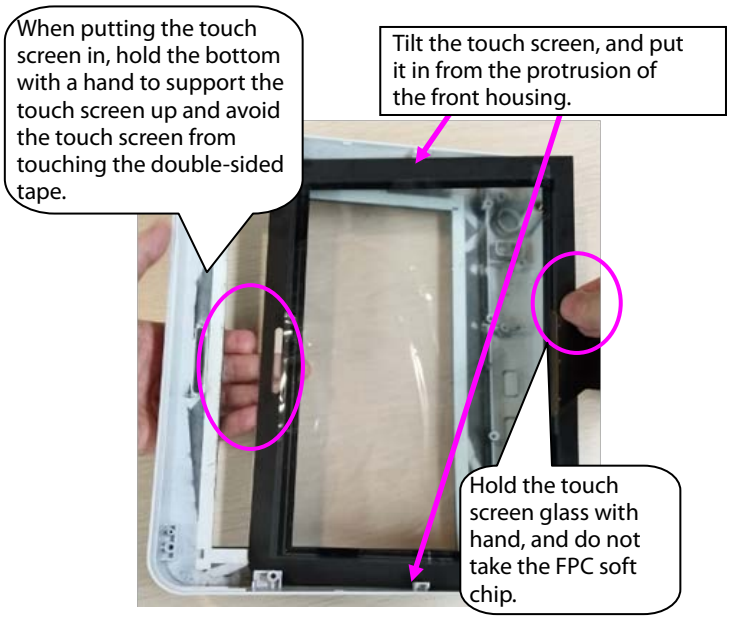
10. Use cutting pliers to cut the binding straps fixing the display screen connection cable and keypad connection cable, remove the cable from the keypad socket, and remove the display screen connection cable and keypad connection cable.



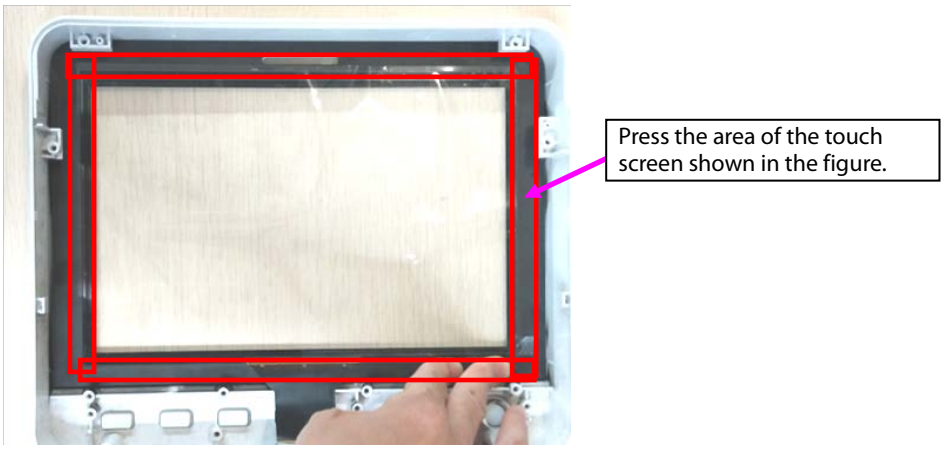
Note 1. During reassembly of the touch screen rubber, follow the requirements below to perform assembly.



Note 2. During reassembly of the touch screen, follow the requirements below to perform assembly.

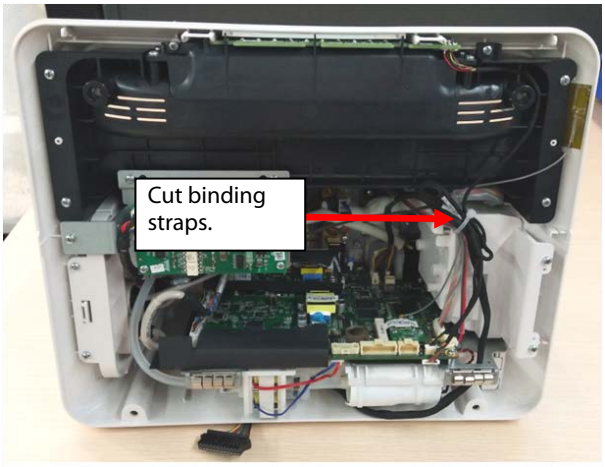


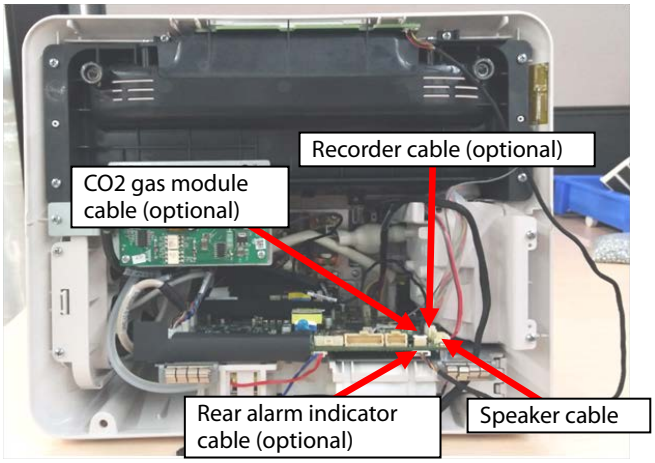
Note 3. After reassembly of the touch screen, follow the requirements below to press the touch screen.



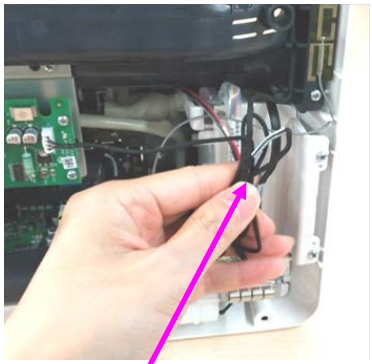
7.4.5 Disassembling WiFi and Parameter Panel

1. Remove cables.

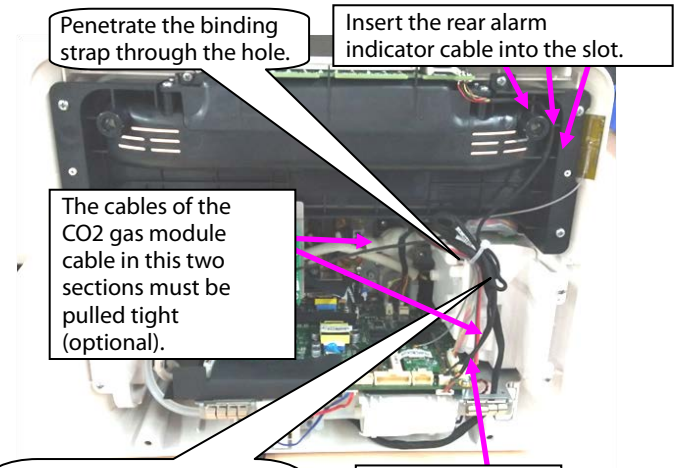




Note. During reassembly, follow the requirements below to perform binding and fixing.



Collect the excessive section of the cables of the rear alarm indicator (optional) and gas module (optional) together using hands.

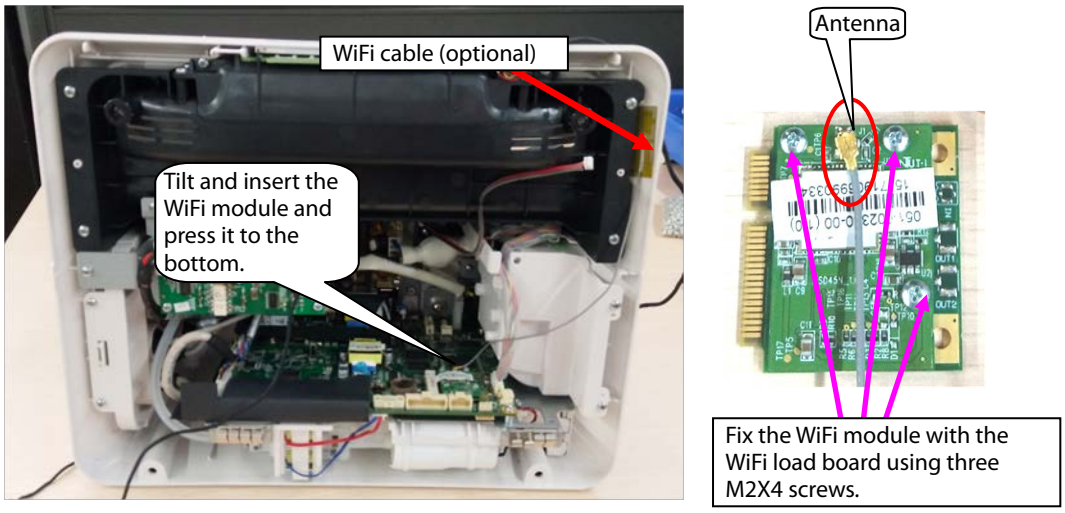


2. When WiFi is configured, disassemble the WiFi module.

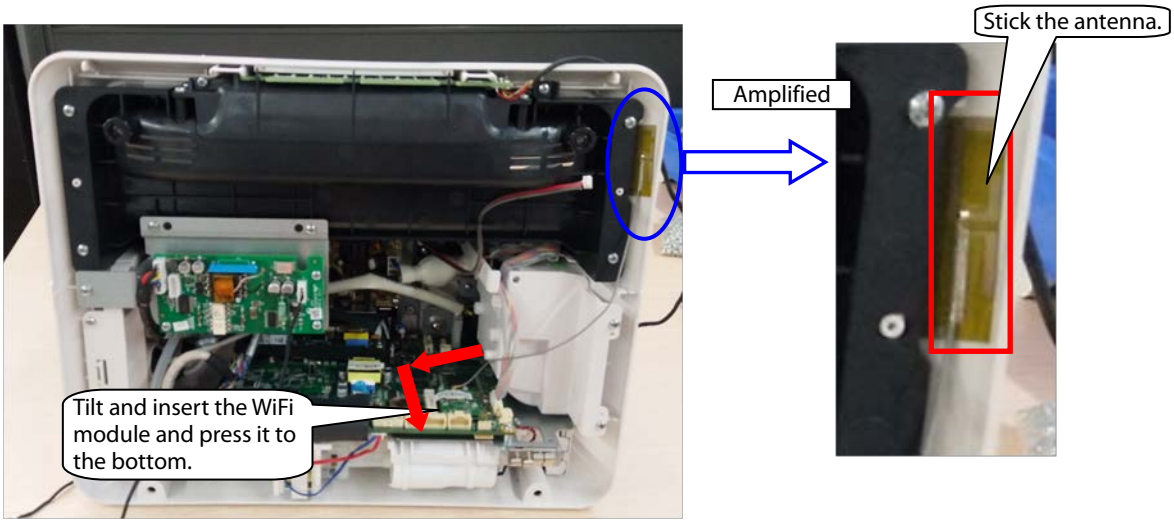
A. Take the WiFi module out.

B. Remove the WiFi cable.

C. Loosen the three M2X4 screws fixing the WiFi module and WiFi load board, and take the WiFi module and WiFi load board out.

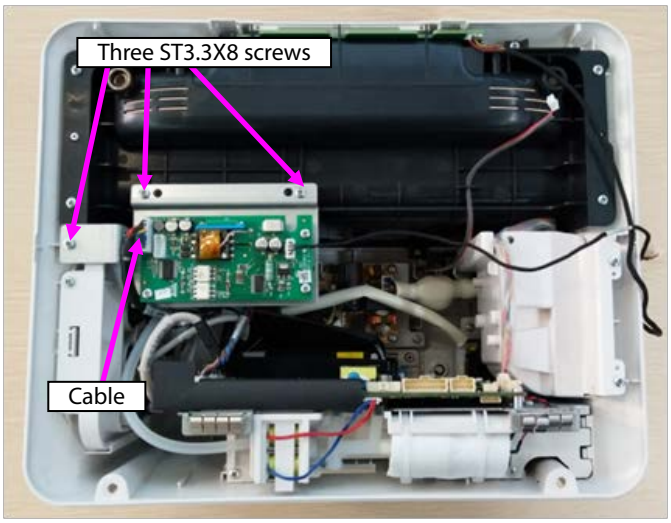


Note. During reassembly of the WiFi module, follow the requirements below to perform assembly.



3. When mainstream CO_2 is configured, disassemble the CO_2 module.

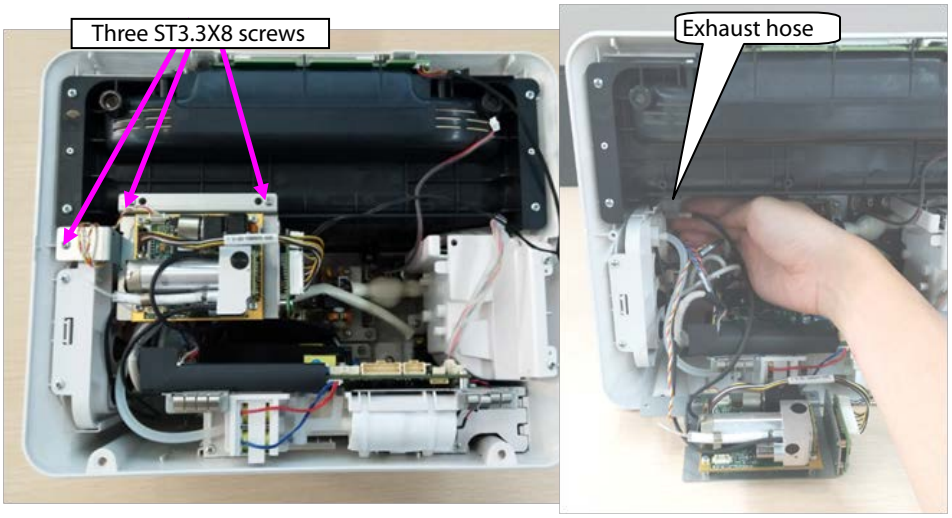
Remove the cables pointed by the arrows in the following figure, loosen three ST3.3X8 cross pan head tapping screws using the screwdriver, and take the module out.



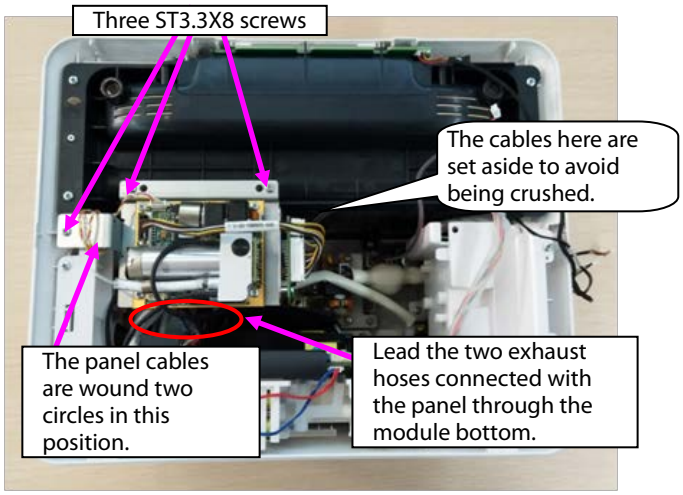
4. When microstream CO_2 is configured, disassemble the CO_2 module.

1. Loosen three ST3.3X8 cross pan head tapping screws using the screwdriver, and take the module out.

B. Remove the connection between the microstream module exhaust hose and panel exhaust hose.

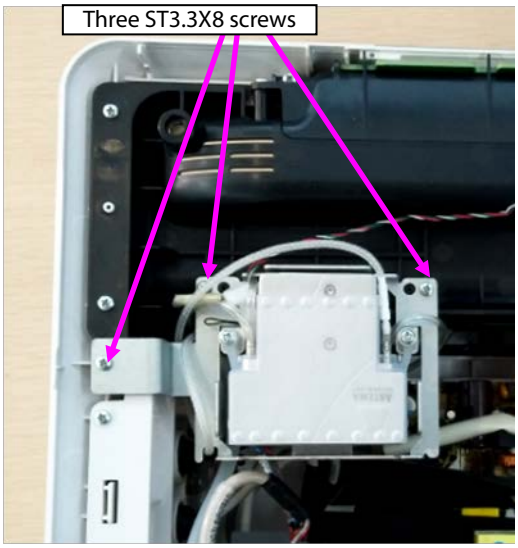


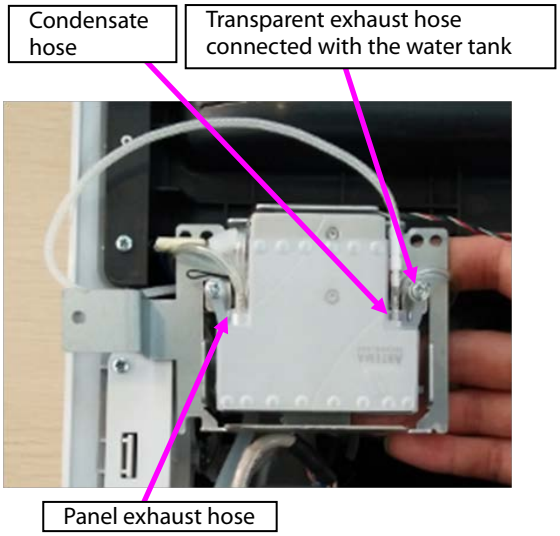
Note. During reassembly of the microstream CO_2 module, follow the requirements below to perform assembly.



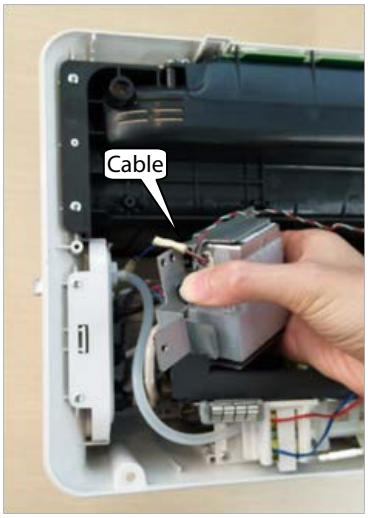
5. When sidestream CO_2 is configured, disassemble the CO_2 module.

A. Loosen three ST3.3X8 cross pan head tapping screws using the screwdriver, and loosen the hose of the sidestream CO_2.

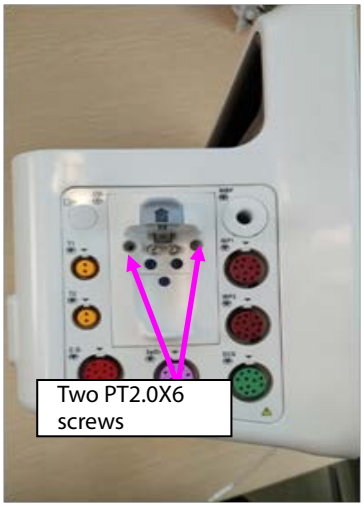


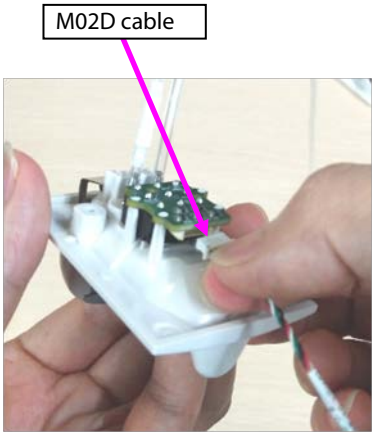


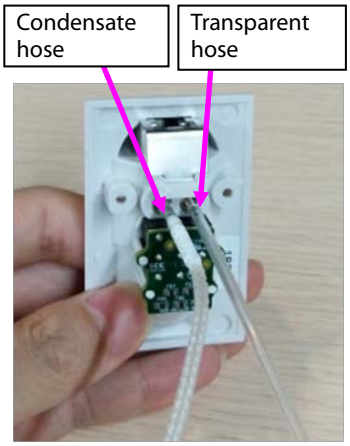
B. Loosen the cable connection, and take the module out.



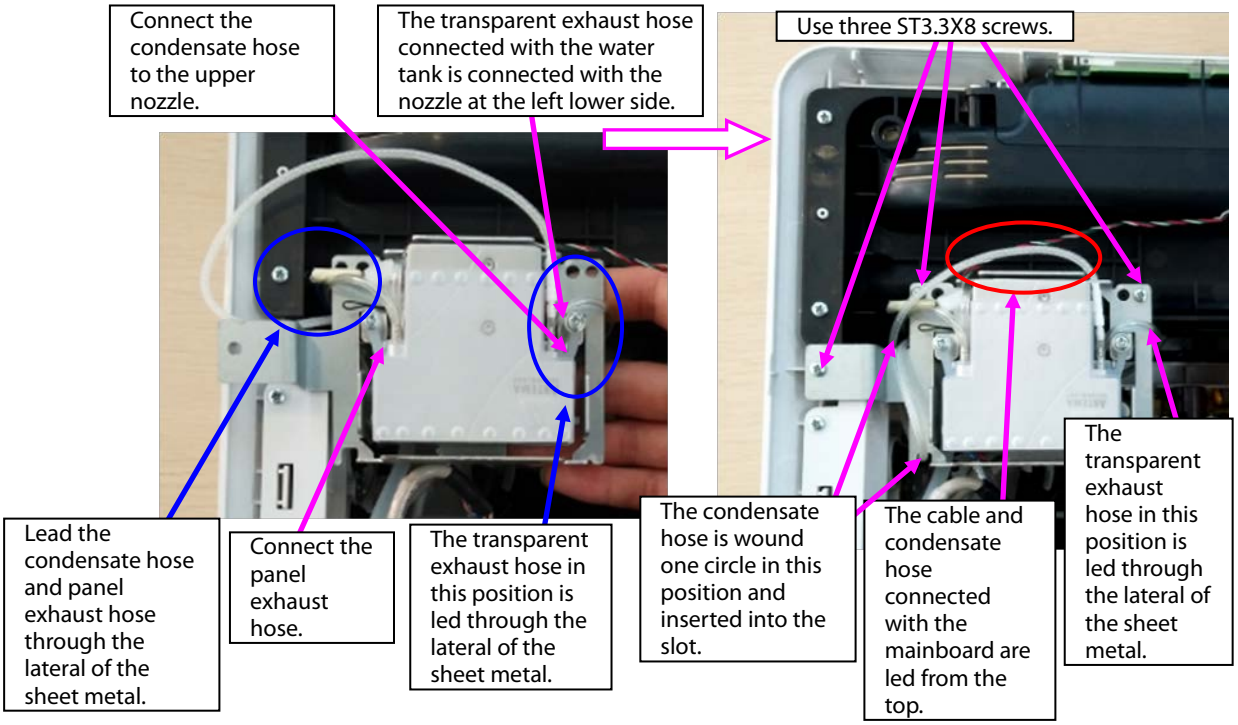
C. Disassemble the two PT2.0X6 screws on the panel water tank, and take the water tank out.



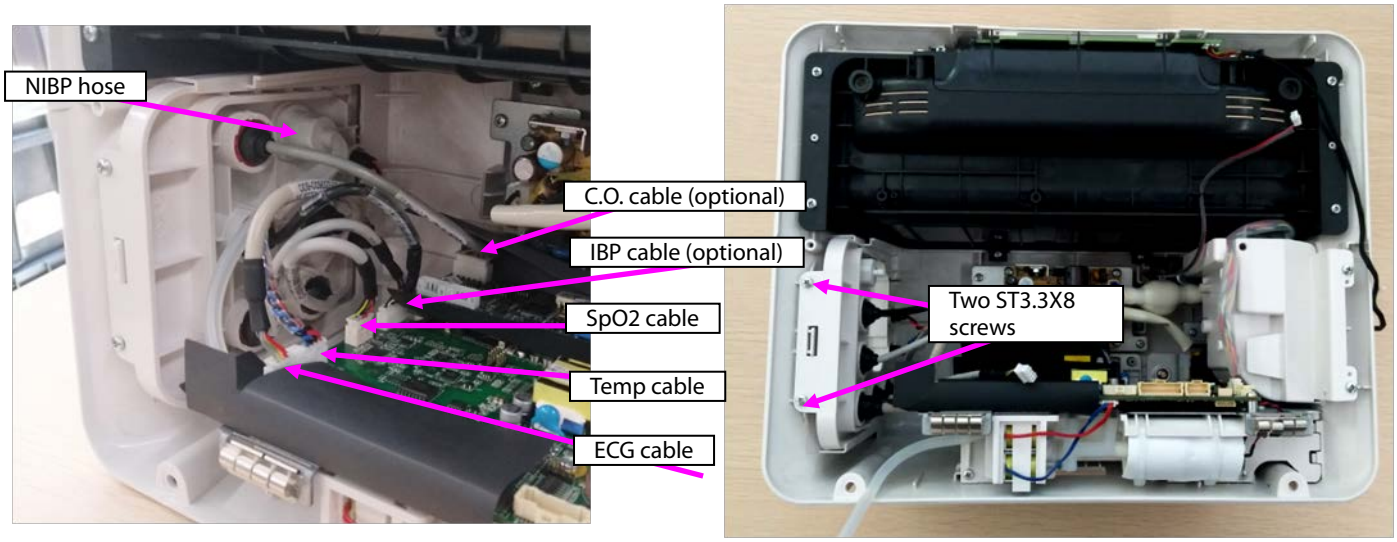




Note. During reassembly of the sidestream CO_2 module, follow the requirements below to perform assembly.



6. Remove the panel cable from the mainboard, and remove the NIBP exhaust hose.
7. Loosen two ST3.3X8 cross pan head tapping screws using the screwdriver, and take the panel fixing pin and panel component out.



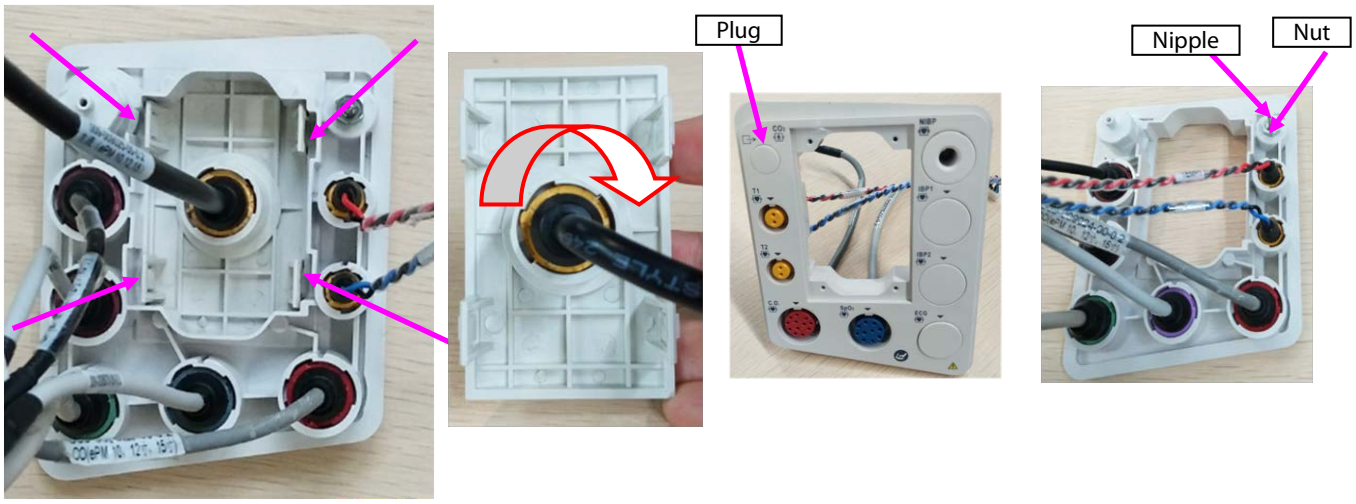
8. When a mainstream module is configured, disassemble the mainstream panel port.

A. Use pliers or tweezers to jack the fastener on the panel, and take the interface board out.

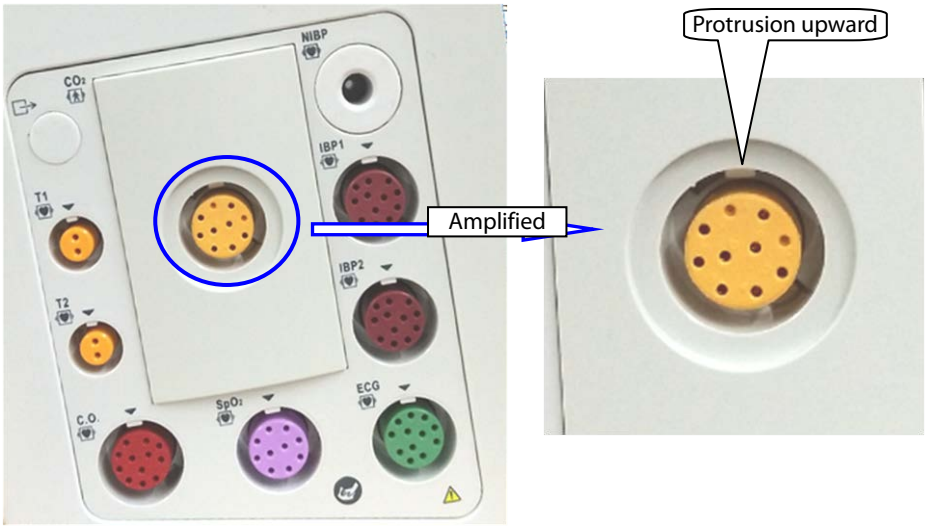
B. Rotate the cable anticlockwise, and remove the CO_2 cable.

C. Remove the plug from the panel.

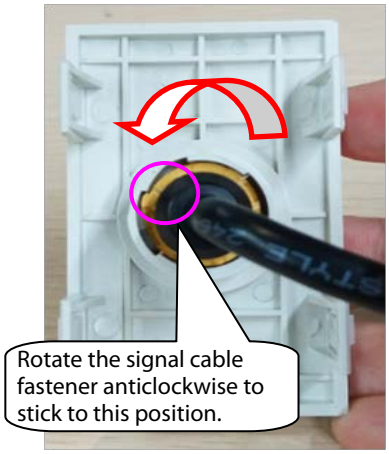
D. Loosen the M5 screw from the upper right corner of the panel, and take the nozzle out.



Note 1. During reassembly, the interface board of the mainstream panel should be in the following direction.



Note 2. During reassembly of the cable to the interface board, tighten it firmly anticlockwise.

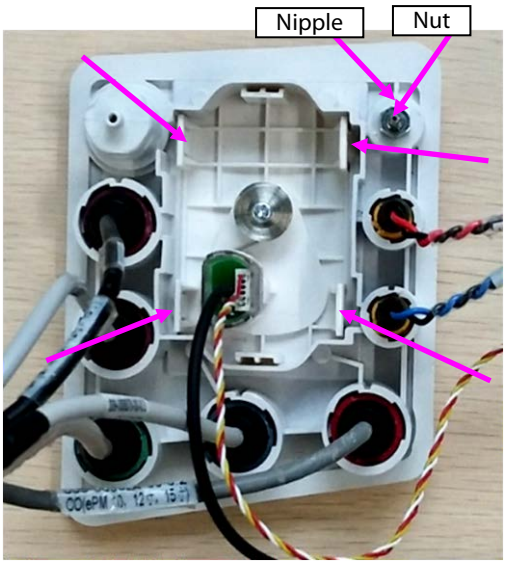


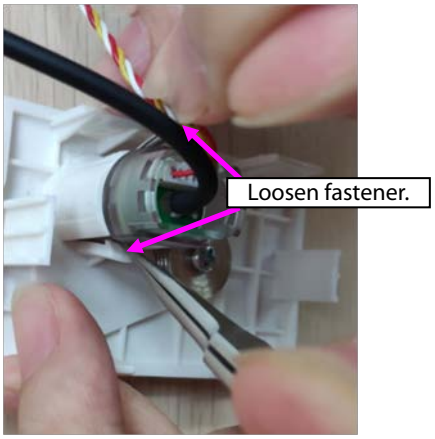
9. When an microstream module is configured, disassemble the microstream water tank.

A. Use pliers or tweezers to jack the fastener on the panel, and take the microstream water tank base out.

B. Loosen the M5 screw from the upper right corner of the panel, and take the exhaust nozzle out.

C. Use tweezers to loosen the fastener on the water tank base, and take the microstream connector out.





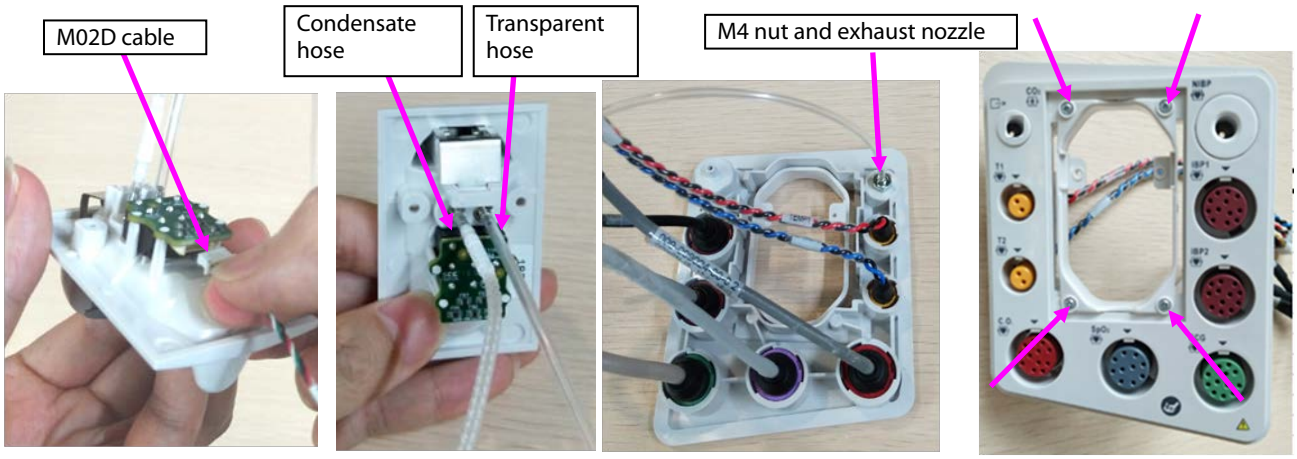
10. When a sidestream module is configured, disassemble the sidestream water tank.

A. Remove the cable or hose from the water tank.

B. Remove the exhaust hose from the panel, loosen the M4 screw on the exhaust nozzle, and take the nozzle out.

C. Loosen the M5 screw/M4 nut on the panel, and take the exhaust nozzle out.

D. Loosen the four PT2.0X6 screws on the panel, and take the bracket of the sidestream water tank out.



11. Disassemble the panel cable.

A. According to the figure, rotate different parameter cables anticlockwise, and remove them.

B. Take the arrival reminding shrapnel out.

Diagram (CO2 gas module is not used)

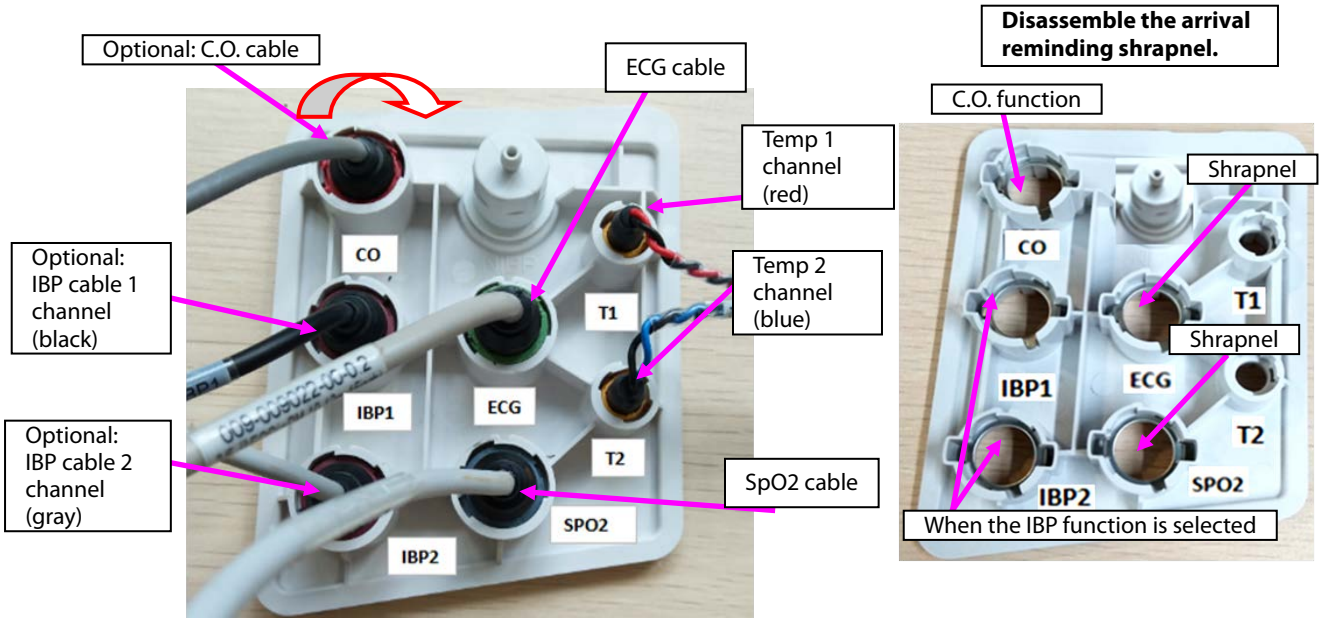
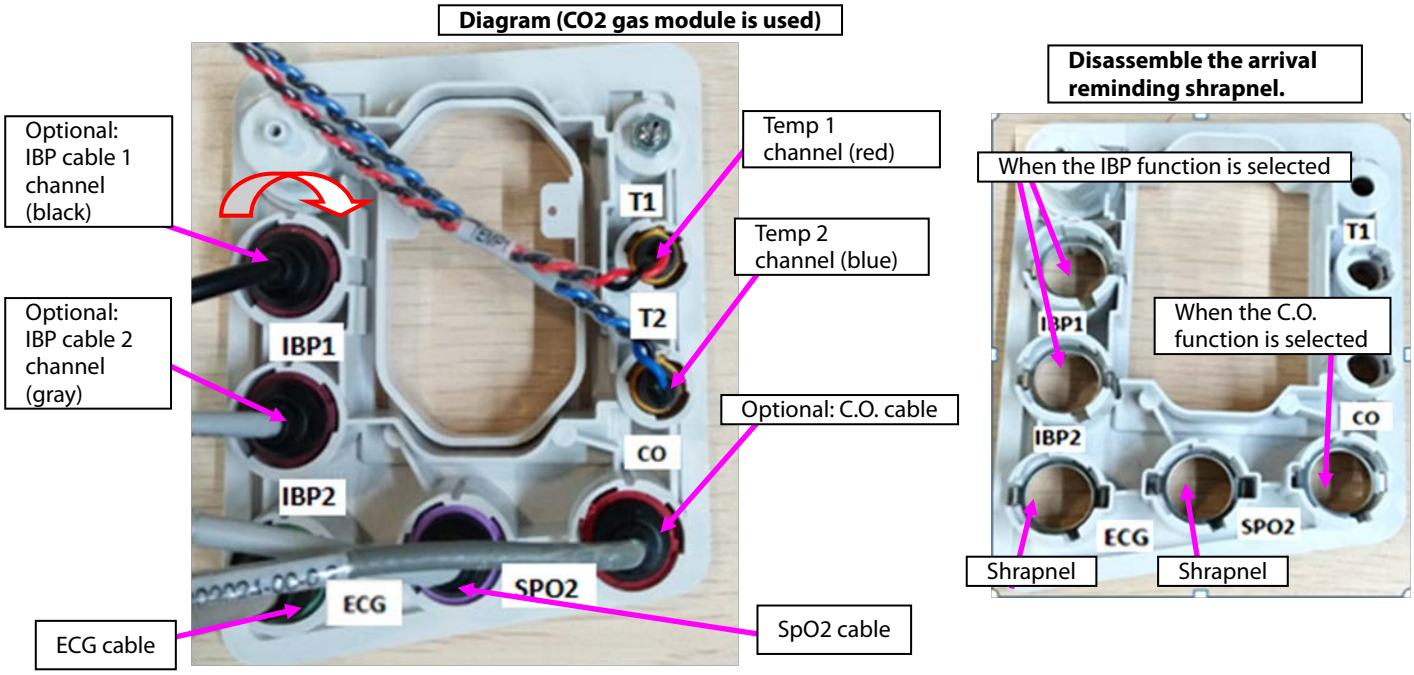
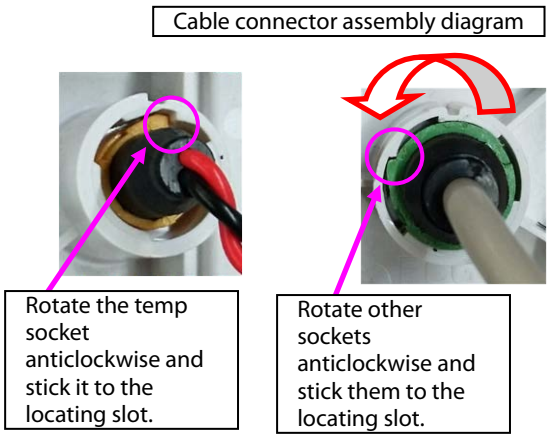


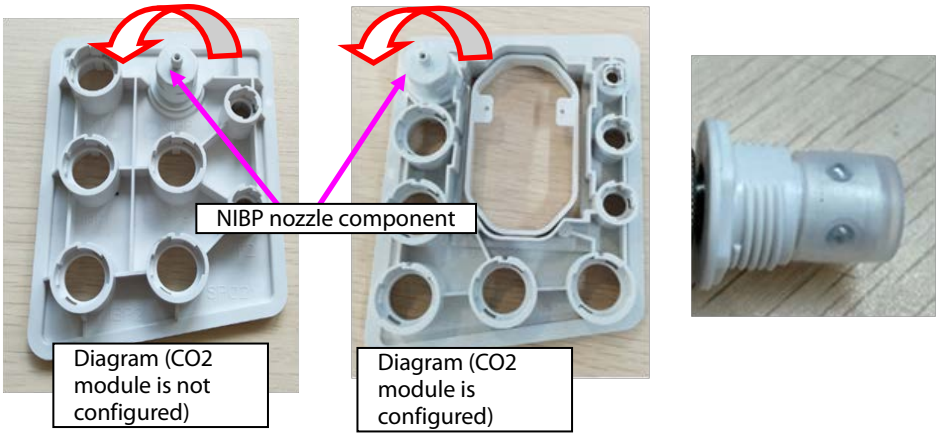
Diagram (CO2 gas module is used)



Note. During reassembly, follow the requirements below to perform cable assembling.



12. Disassemble the NIBP nozzle: Rotate the NIBP nozzle anticlockwise, and disassemble the NIBP nozzle.

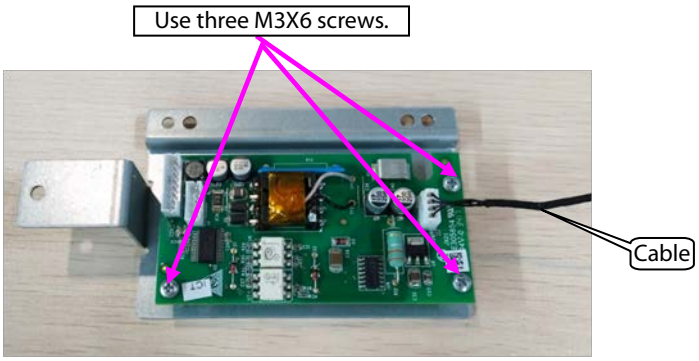


7.4.6 Disassembling Gas Module

1. When mainstream CO_2 is configured:

A. Loosen the three M3X6 screws in the figure, and take the mainstream CO_2 isolation power board out.

B. Remove the cable connecting the mainstream isolation power board with the mainboard.



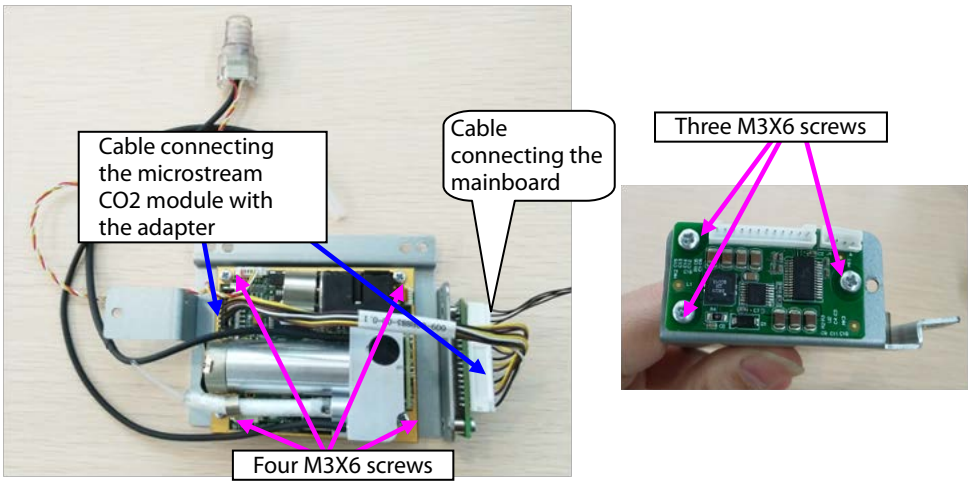
2. When microstream CO_2 is configured:

A. Remove the cable connecting the microstream CO_2 module with the adapter.

B. Remove the cable connecting the mainboard.

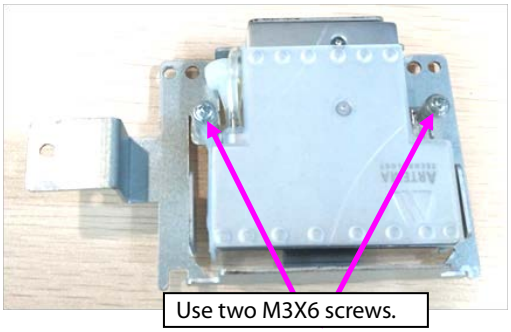
C. Loosen the four M3X6 screws in the figure, and take the microstream CO_2 module out.

D. Loosen the three M3X6 screws, and take the adapter out.



3. When sidestream CO_2 is configured:

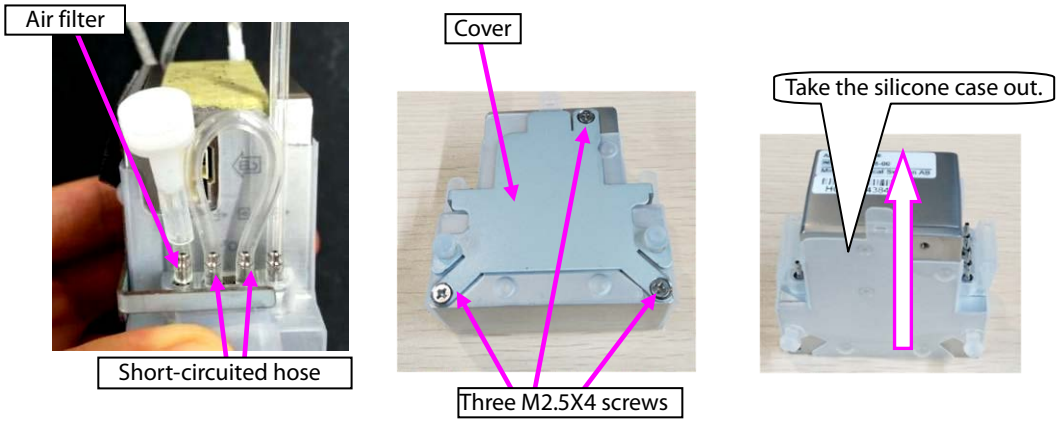
A. Loosen the two M3X6 screws in the figure, and take the sidestream gas module out.



B. Take the air filter and short-circuited hose out.

C. Loosen the three M2.5X4 countersunk screws, and take the cover out.

D. Take the silicone case out.

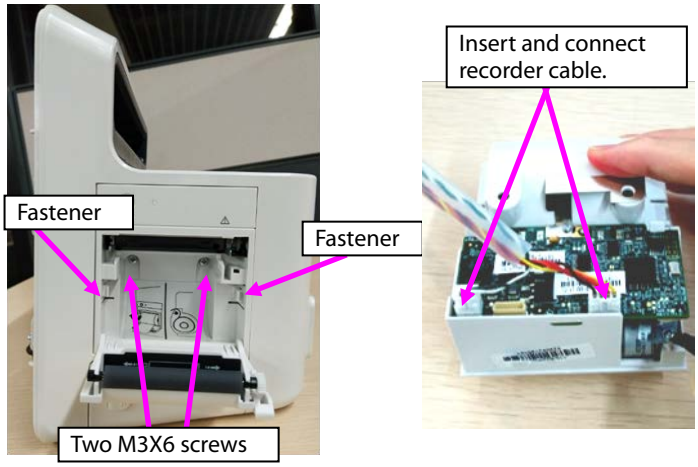


7.4.7 Disassembling Recorder/Recorder Bracket

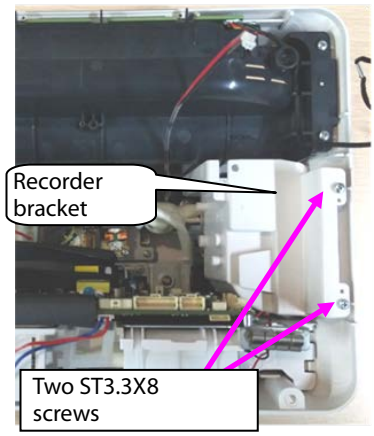
1. When the recorder is configured, disassemble the recorder:

A. Loosen the two M3X6 screws of the recorder, loosen the two fasteners of the recorder, and take the recorder out.

B. Remove the cable connecting the two sockets of the recorder.

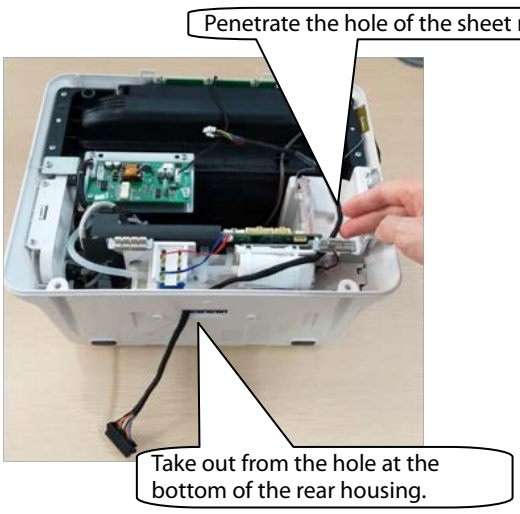


2. Take the recorder bracket out: Loosen the two ST3.3X8 screws on the recorder bracket, and take the recorder bracket out.



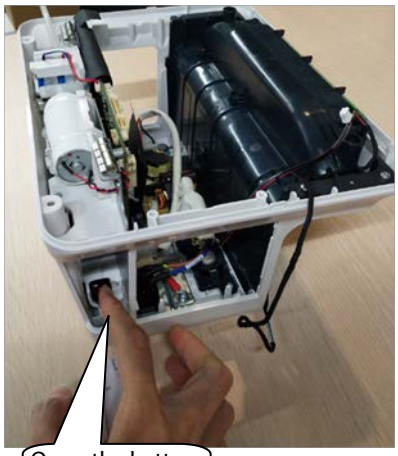
7.4.8 Disassembling Main Bracket Component

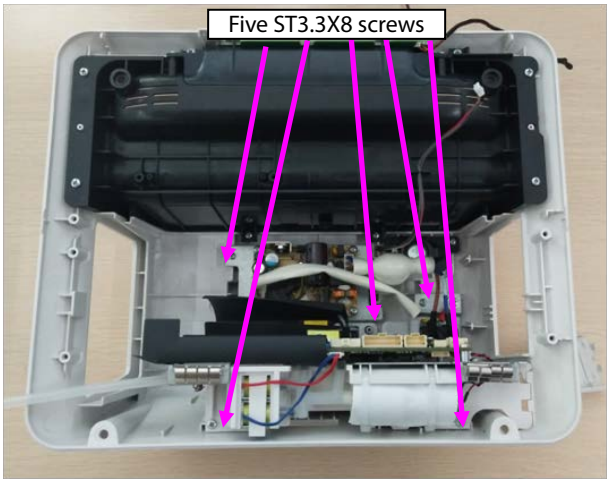
1. When the battery box is configured, remove the cable connecting the battery box.



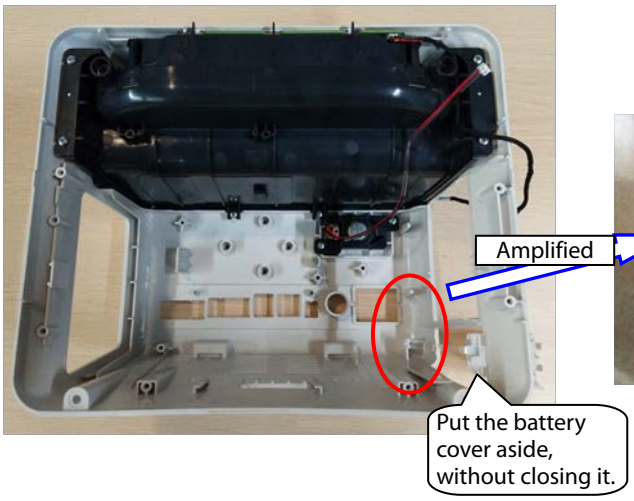
2. Loosen the battery cover.

3. Loosen the five ST3.3X8 screws shown in the figure, and remove the main bracket component.

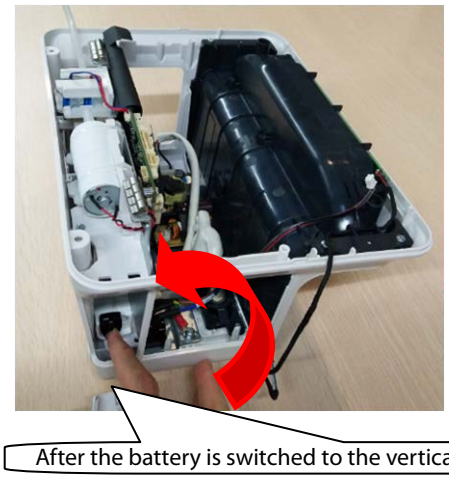




Note 1. Before reassembling the main bracket component, insert the connection belt of the battery cover to the locating post of the rear housing shown in the following figure.

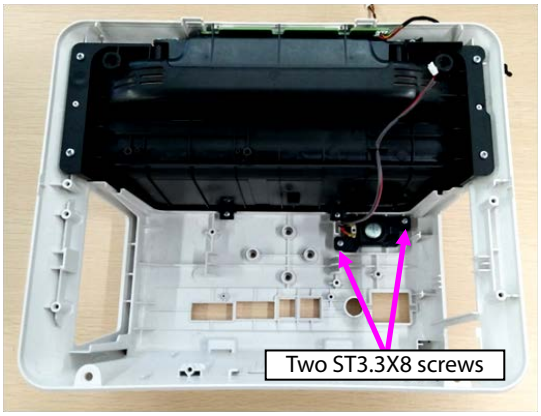


Note 2. Before closing the battery cover, switch the battery to the vertical position shown in the figure.



7.4.9 Disassembling Speaker

1. Loosen the two ST3.3X8 screws of the speaker component shown in the figure, and take the speaker component out.

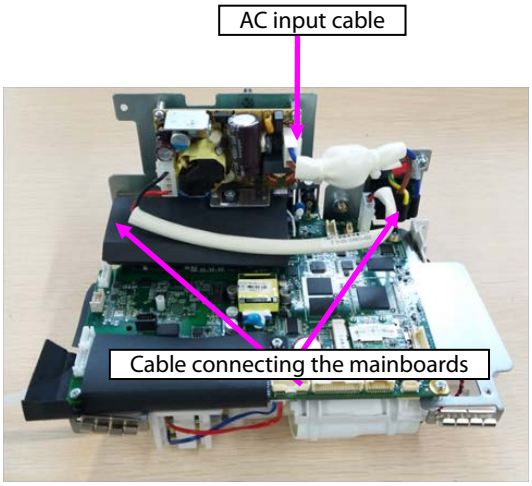


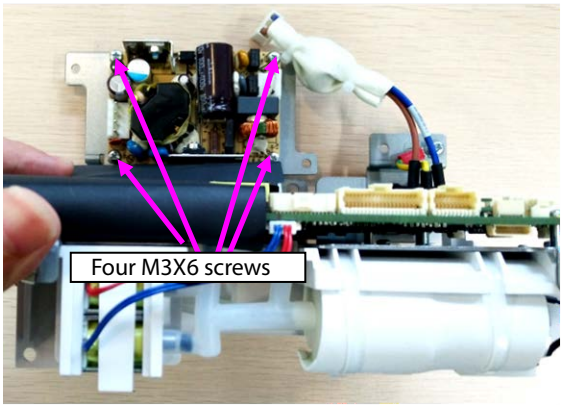
7.4.10 Disassembling Rear Alarm Indicator (Configured)

1. Loosen the eight ST3.3X8 screws on the cover component shown in the figure, and take the top cover component out.
2. Loosen the one ST3.3X8 screw on the rear alarm indicator shown in the figure, and take the rear alarm indicator component out.

7.4.11 Disassembling Power Module

1. Remove the AC input cable, and remove the cable connecting the power module with mainboard out.
2. Loosen the four M3X6 screws of the power module, and take the power module out.

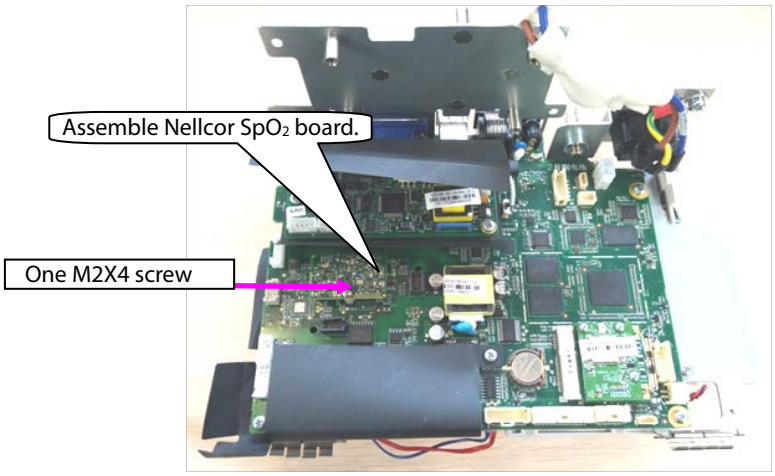




7.4.12 Disassembling SpO_2 Module (When Nellcor/Massimo SpO_2 Is Configured)

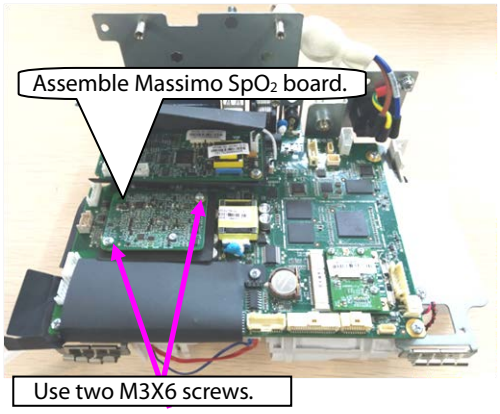
1. When Nellcor SpO_2 is configured:

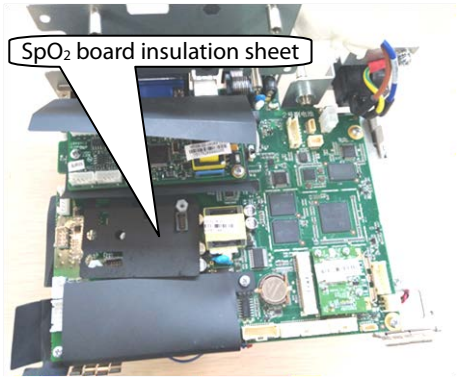
Loosen the one M2X4 screw on the Nellcor SpO_2, and take the Nellcor SpO_2 board out.



2. When Massimo SpO_2 is configured:

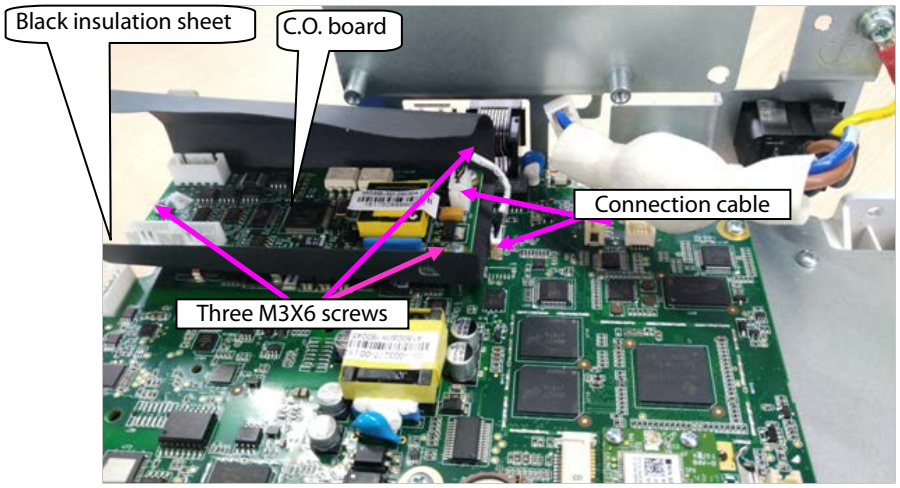
Loosen the two M2X4 screws on the Massimo SpO_2, and take the Massimo SpO_2 board and insulation sheet out.





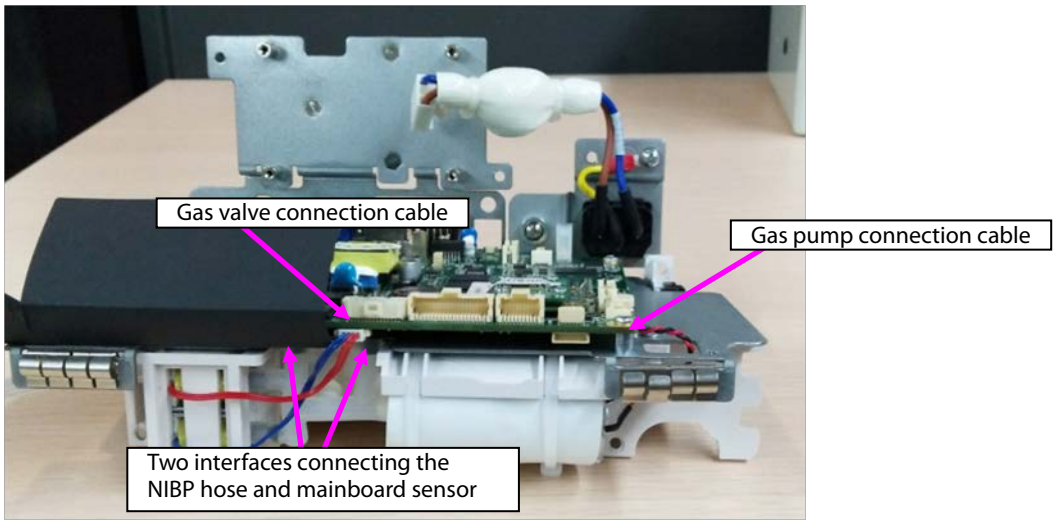
7.4.13 Disassembling C.O. Board (Configured)

1. Remove the cable connecting the C.O. board with the mainboard.
2. Loosen the two M3X6 screws on the Massimo SpO_2, and take the C.O. board and insulation sheet out.

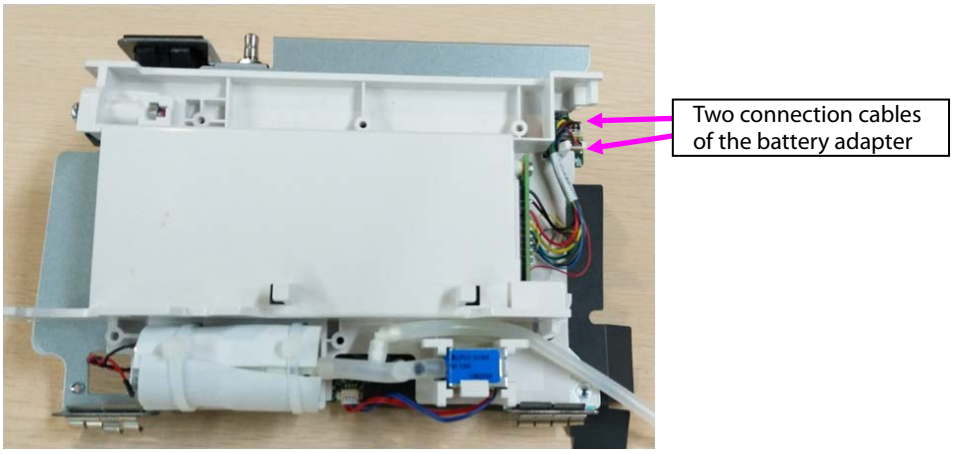


7.4.14 Disassembling Mainboard

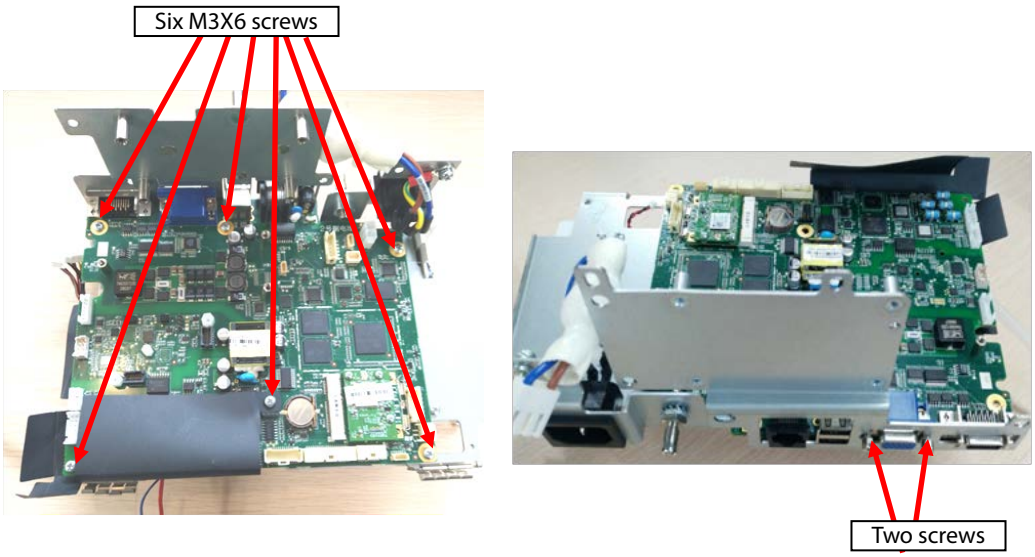
1. Remove the pump/valve connection cables from the mainboard.
2. Take the two interfaces of the NIBP hose from the mainboard sensor.



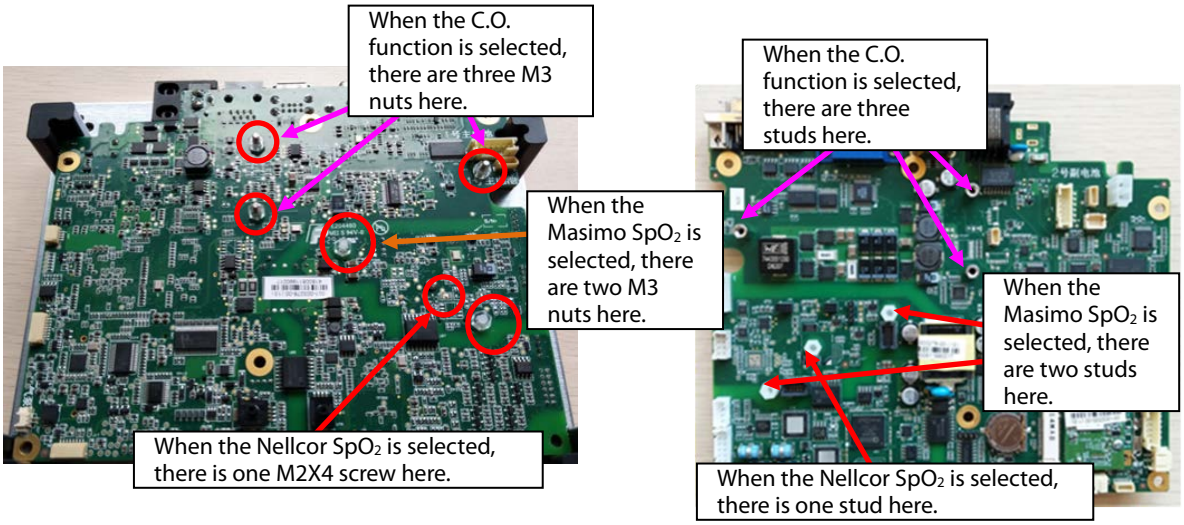
3. Remove the connection cable of the battery adapter from the mainboard.



4. Loosen the six M3X6 screws from the main bracket in the figure.
5. Loosen the two screws on the rear of the main bracket sheet metal, and take the mainboard out.

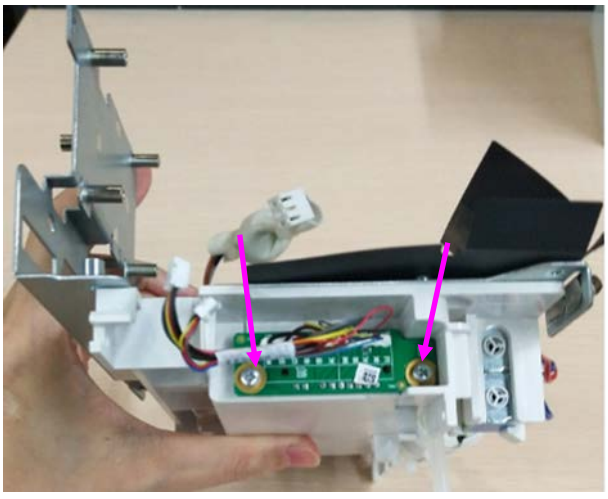


6. As shown in the following figure, loosen the nuts or screws on the rear of the mainboard, and take the studs out.

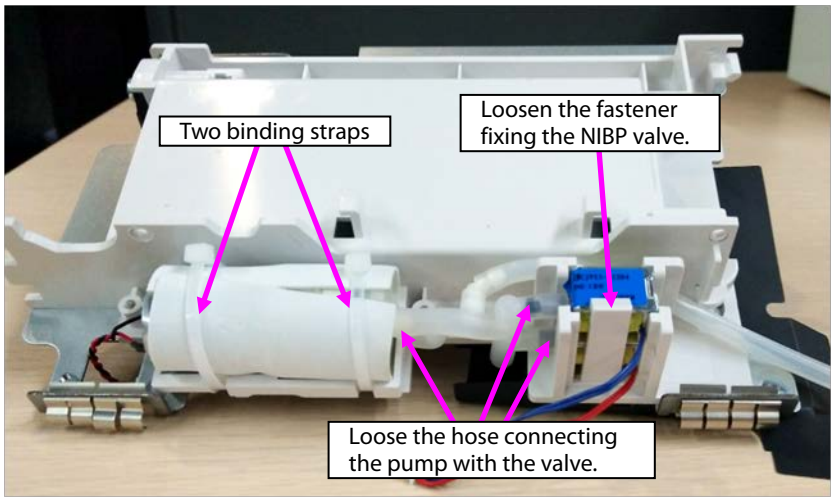


7.4.15 Disassembling Power Adapter and NIBP Pump/Valve

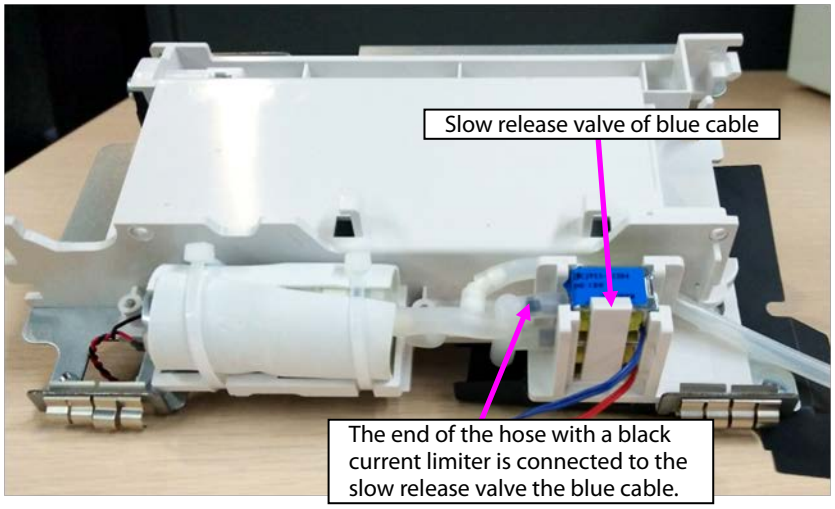
1. As shown in the following figure, loosen the two ST3.3X8 screws, and take the battery adapter out.



2. Loosen the hose connecting the NIBP pump/valve.
3. Loosen the fastener fixing the NIBP valve, and take the NIBP valve out.
4. Loosen the two binding straps fixing the NIBP pump, and take the NIBP pump out.



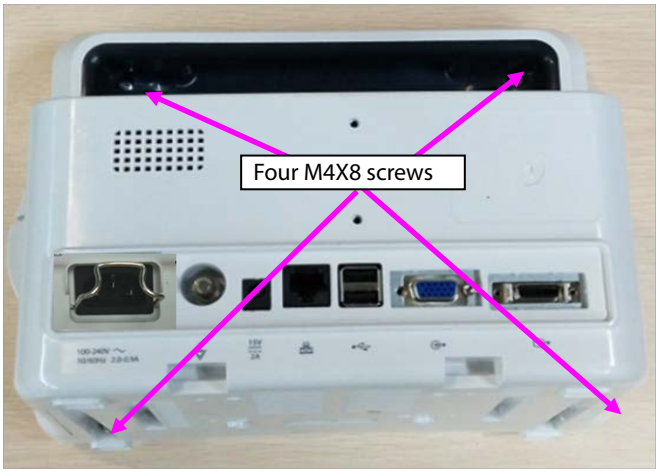
Note: During reassembly, ensure that the hose is correctly connected with the quick/slow release valve.



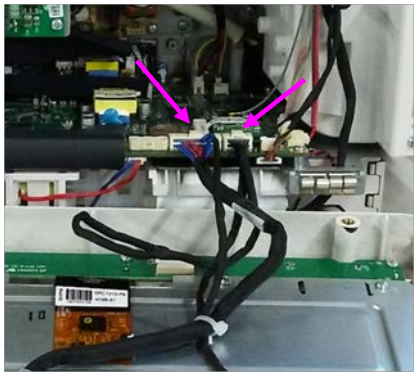
7.5 ePM 10/ePM 10A/ePM 10C Host Disassembly

7.5.1 Disassembling Front/rear Housing Components of Host

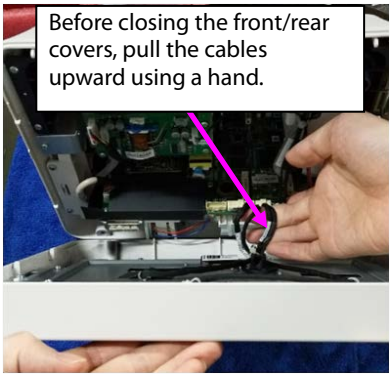
1. Use a Phillips screwdriver to loosen four M4X8 screws.



2. Open the front/rear housings, and remove the display screen connection cable and keypad connection cable.

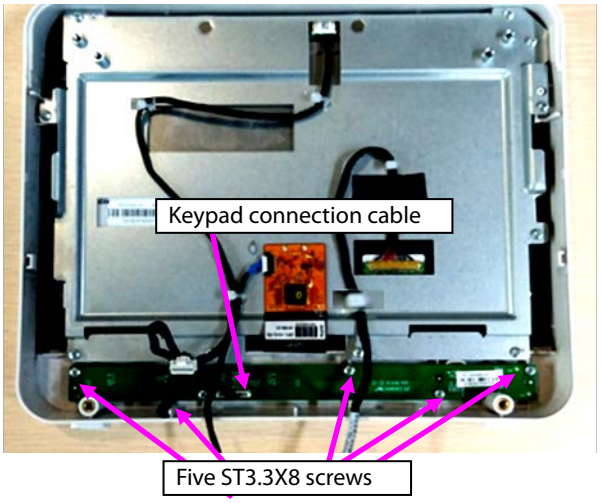


Note: During reassembly, close the front/rear covers and pull the cables upward using a hand.



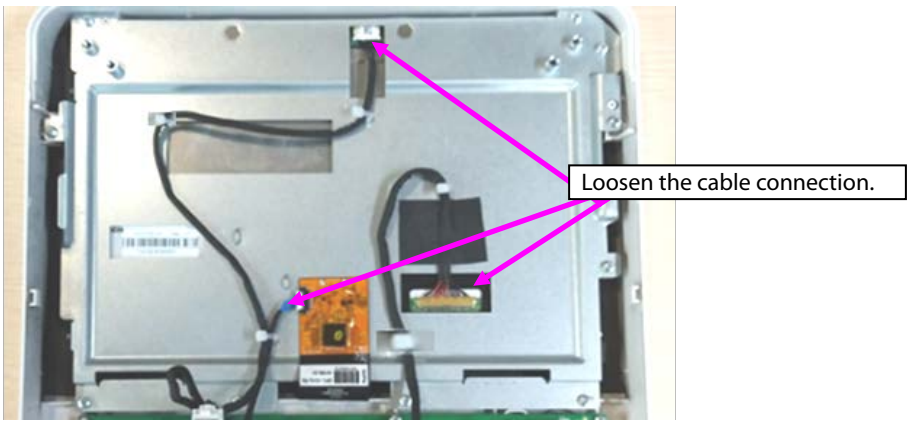
7.5.2 Disassembling Keypad

1. Remove the cable connecting the keypad.
2. Loosen the five ST3.3X8 screws shown in the figure, and take the keypad out.

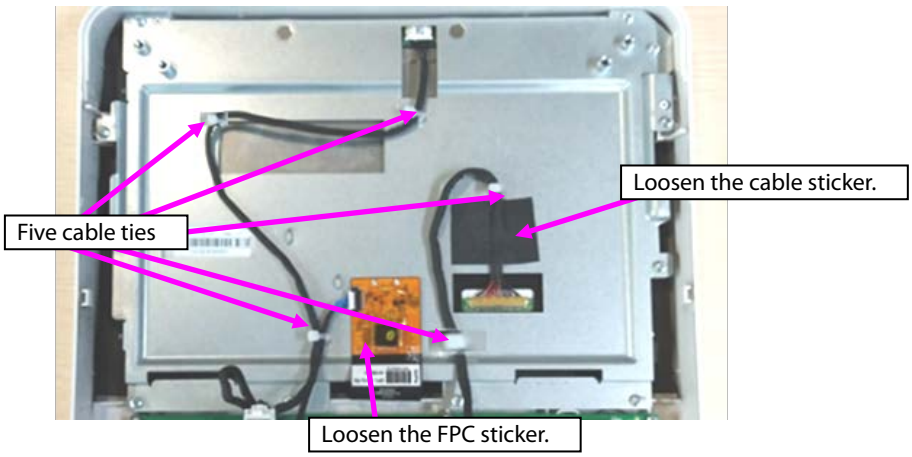


7.5.3 Disassembling Display Screen and Alarm Indicator

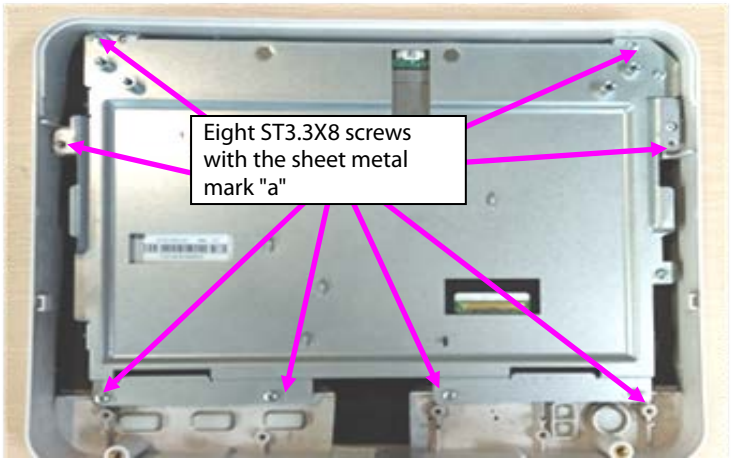
1. Remove the cables connecting with the touch screen, display screen, and alarm indicator.



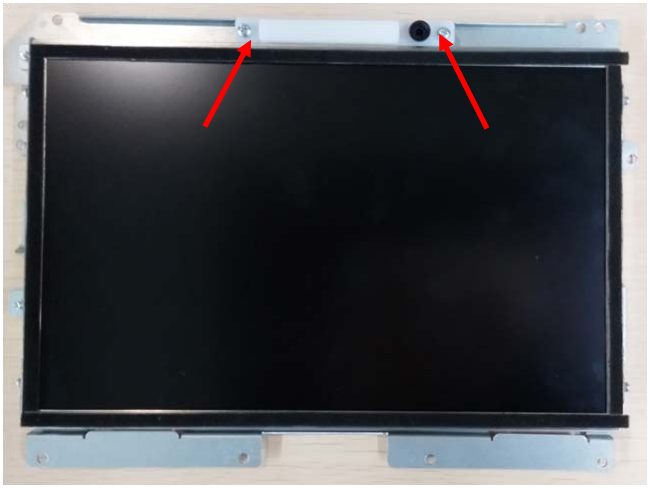
2. Remove the five cable ties from cables, and loosen the cables stuck to the sheet metal.
3. Loosen the sticker connecting the touch screen PFC with the sheet metal.



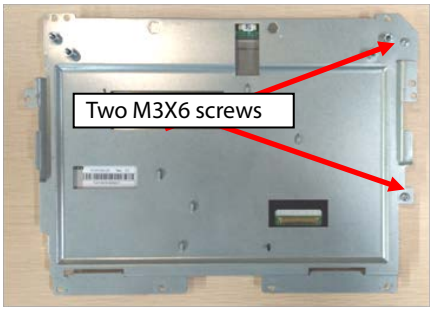
4. Loosen the eight ST3.3X8 screws shown in the figure, and remove the display screen component.

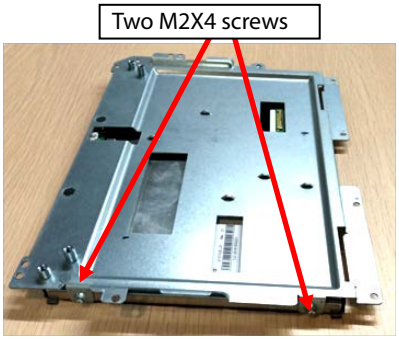


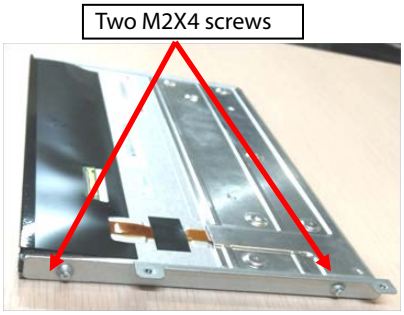
5. Loosen the two M3X6 screws, and take the alarm indicator board out.



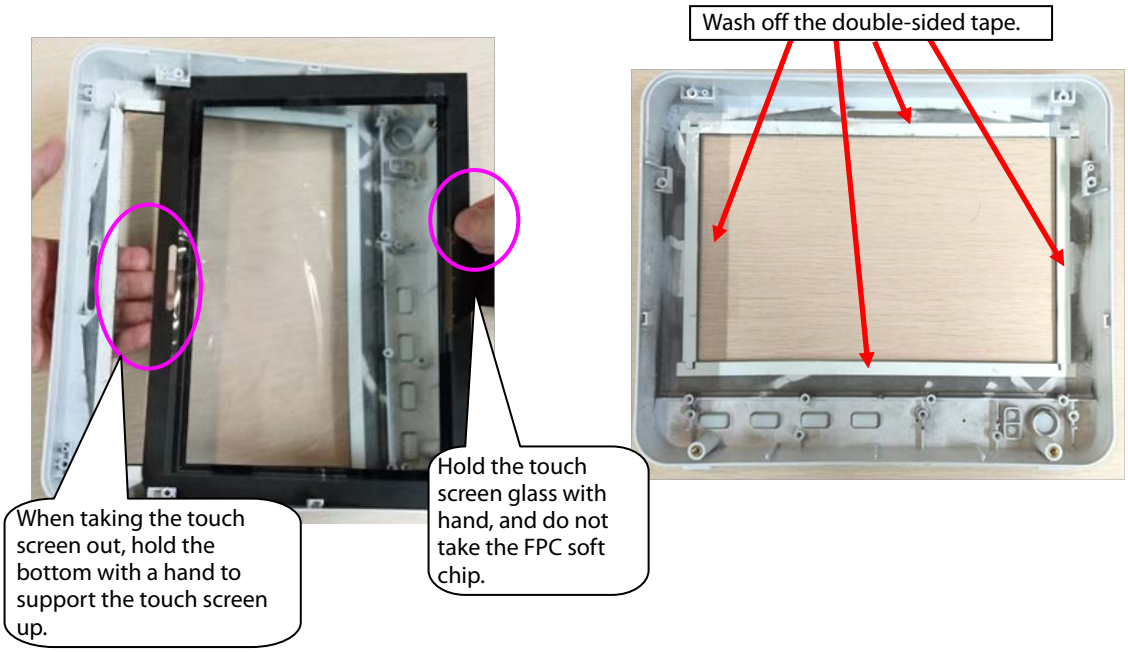
6. Loosen the two M3X6 screws with the mark "b" on the right top of the sheet metal.
7. Loosen the two M2X4 screws at the left side of the sheet metal.
8. Loosen the two M2X4 screws at the left side of the sheet metal, and take the display screen out.



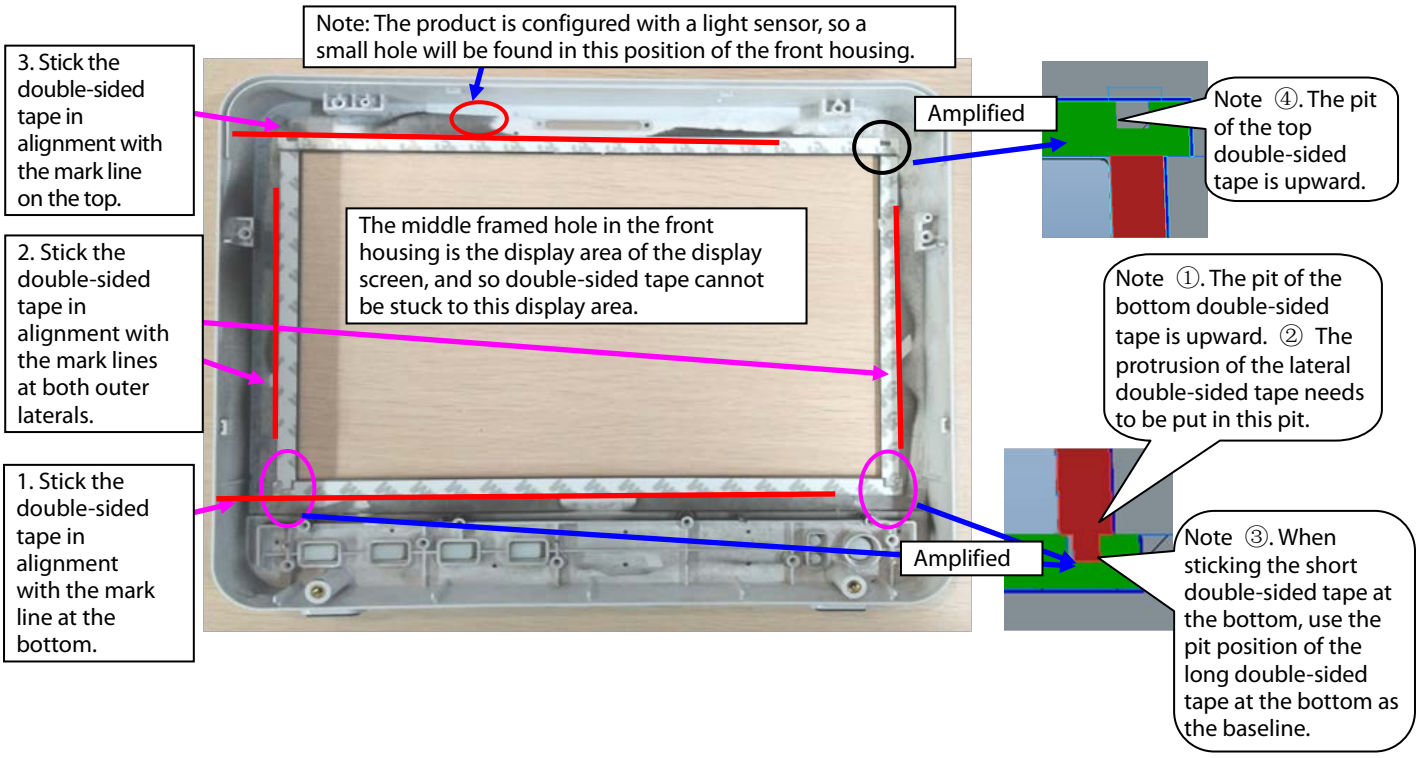




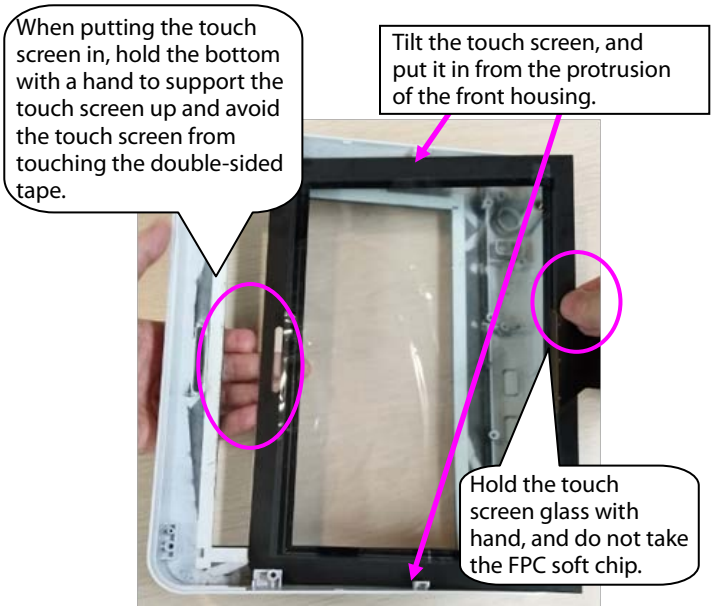
9. Loosen the sticker connecting the touch screen with the front housing, and tilt and take the touch screen out.



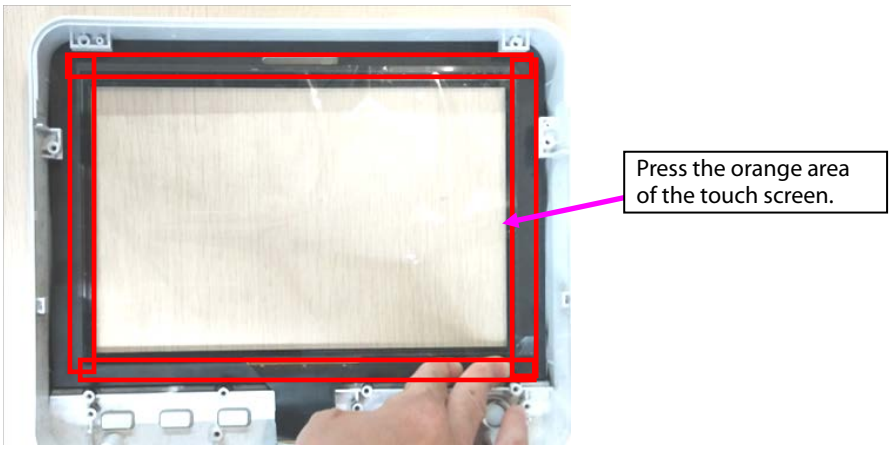
Note 1. During reassembly of the touch screen rubber, follow the requirements below to perform assembly.



Note 2. During reassembly of the touch screen, follow the requirements below to perform assembly.

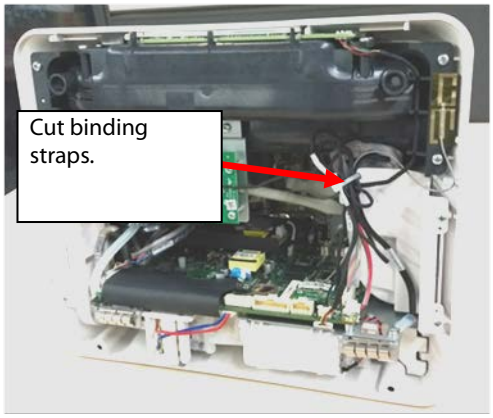


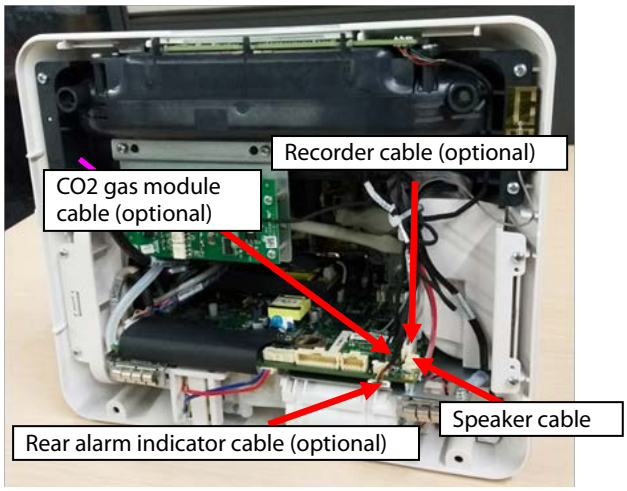
Note 3. After reassembly of the touch screen, follow the requirements below to press the touch screen.



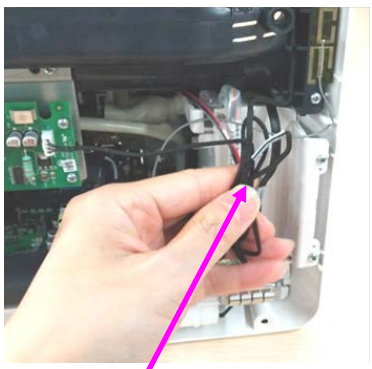
7.5.4 Disassembling WiFi and Parameter Panel

1. Remove cables.

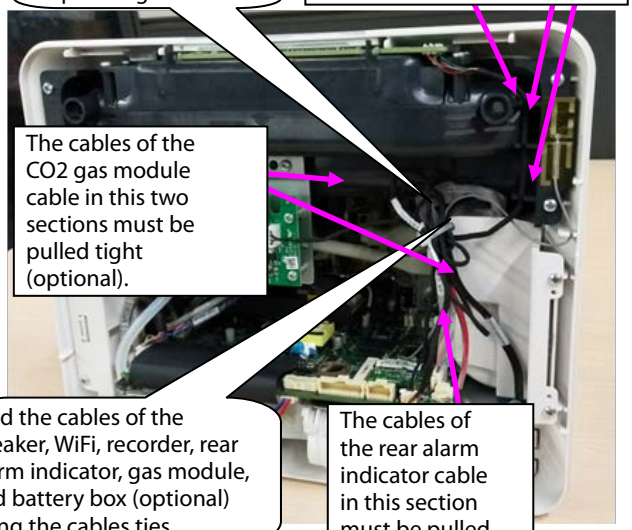




Note. During reassembly, follow the requirements below to perform binding and fixing.



Collect the excessive section of the cables of the rear alarm indicator (optional) and gas module (optional) together using hands.

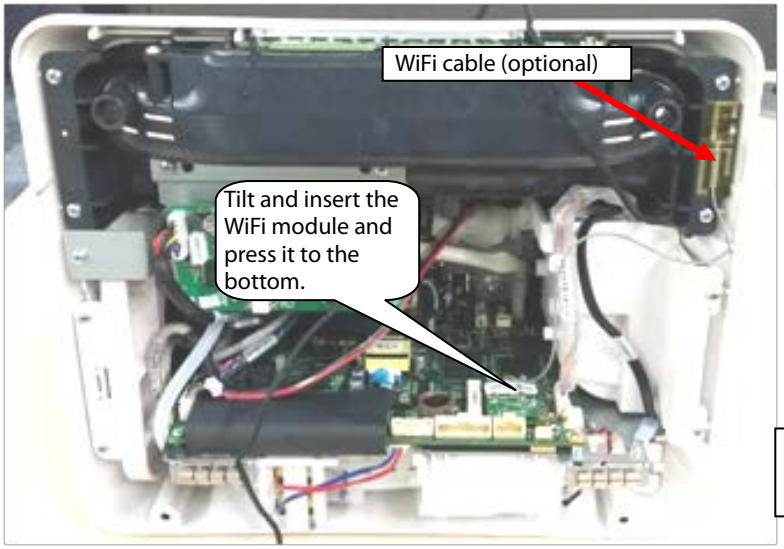


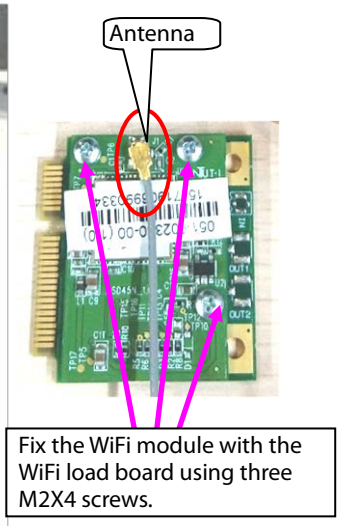
2. When WiFi is configured, disassemble the WiFi module.

A. Take the WiFi module out.

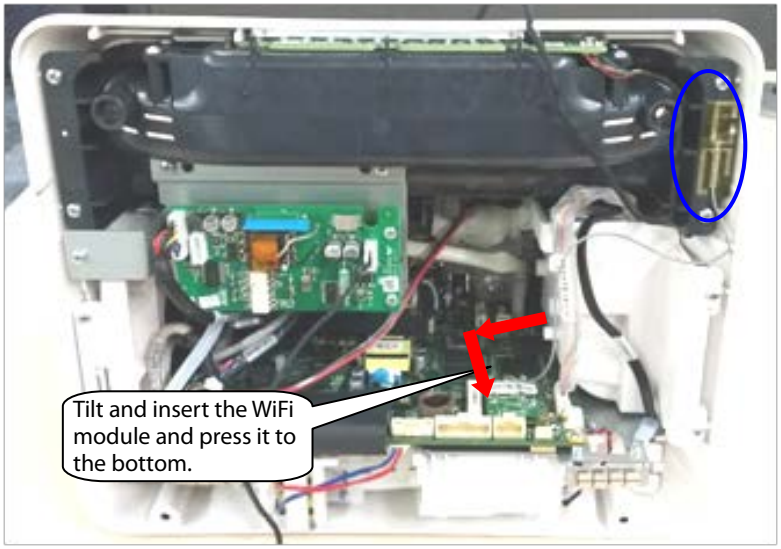
B. Remove the WiFi cable.

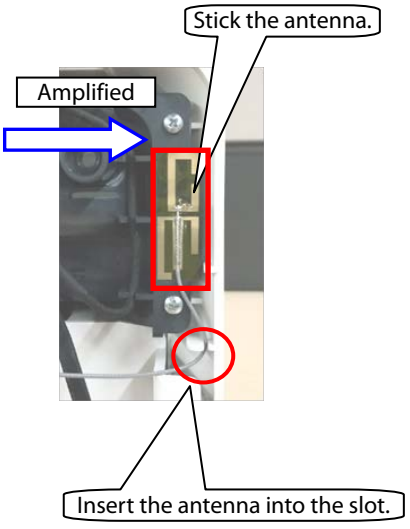
C. Loosen the three M2X4 screws fixing the WiFi module and WiFi load board, and take the WiFi module and WiFi load board out.





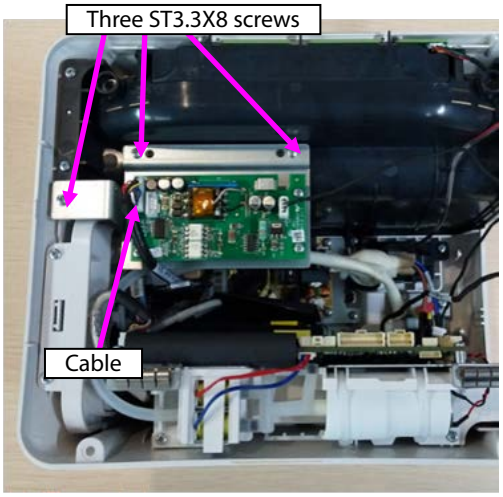
Note. During reassembly of the WiFi module, follow the requirements below to perform assembly.





3. When mainstream CO_2 is configured, disassemble the CO_2 module.

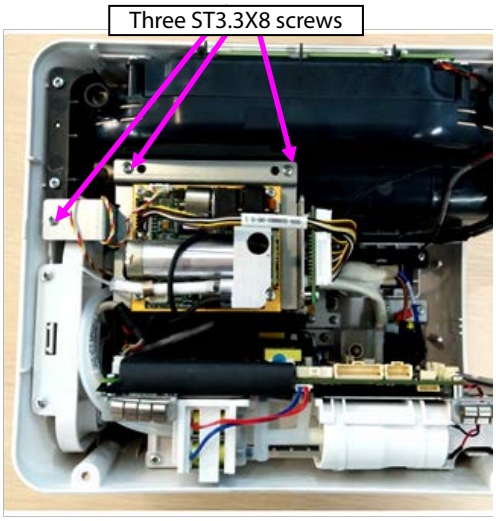
Remove the cables pointed by the arrows in the following figure, loosen three ST3.3X8 cross pan head tapping screws using the screwdriver, and take the module out.

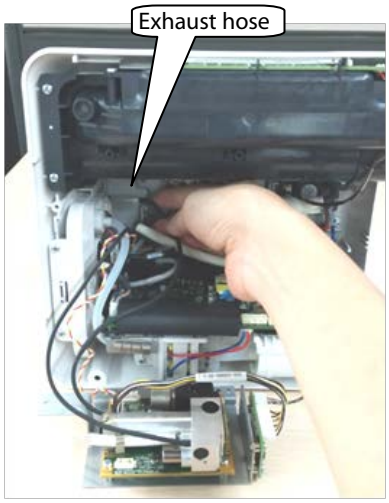


4. When microstream CO_2 is configured, disassemble the CO_2 module.

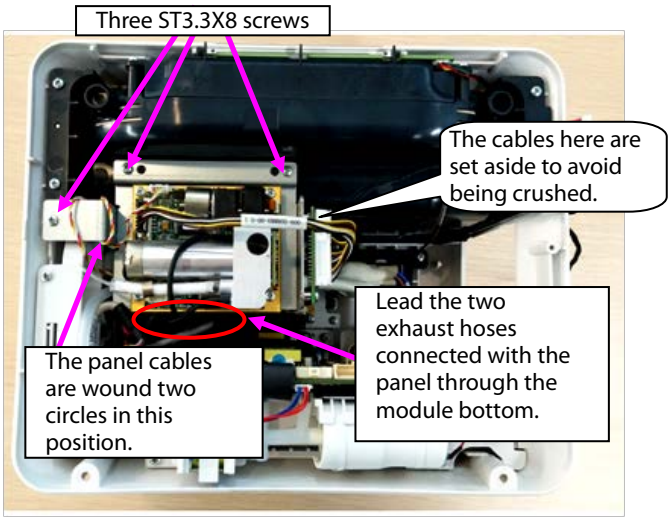
A. Loosen three ST3.3X8 cross pan head tapping screws using the screwdriver, and take the module out.

B. Remove the connection between the microstream module exhaust hose and panel exhaust hose.



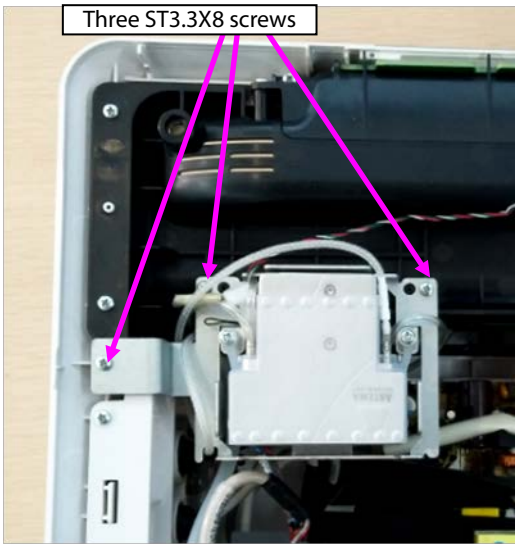


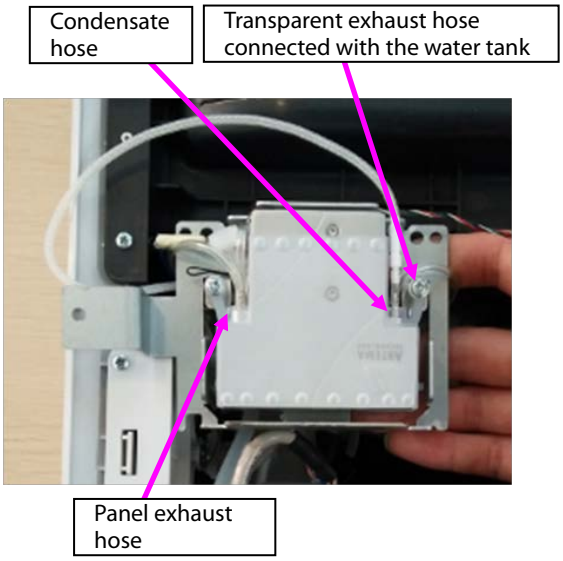
Note. During reassembly of the microstream CO_2 module, follow the requirements below to perform assembly.



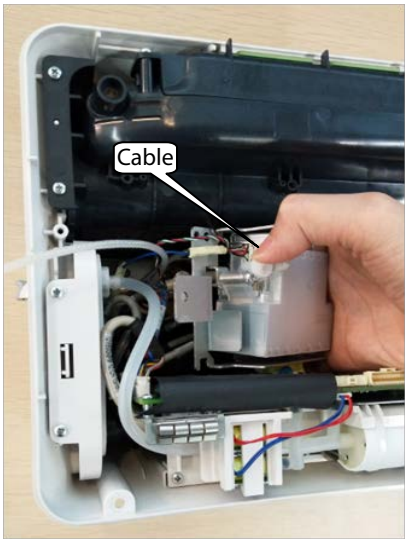
5. When sidestream CO_2 is configured, disassemble the CO_2 module.

A. Loosen three ST3.3X8 cross pan head tapping screws using the screwdriver, and loosen the hose of the sidestream CO_2.

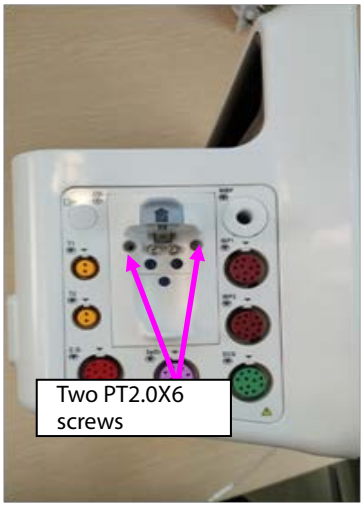


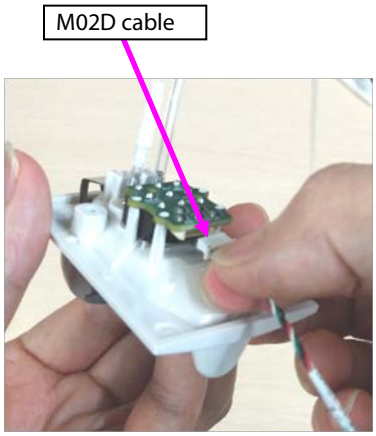


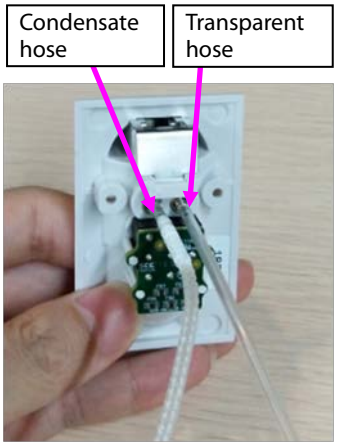
B. Loosen the cable connection, and take the module out.



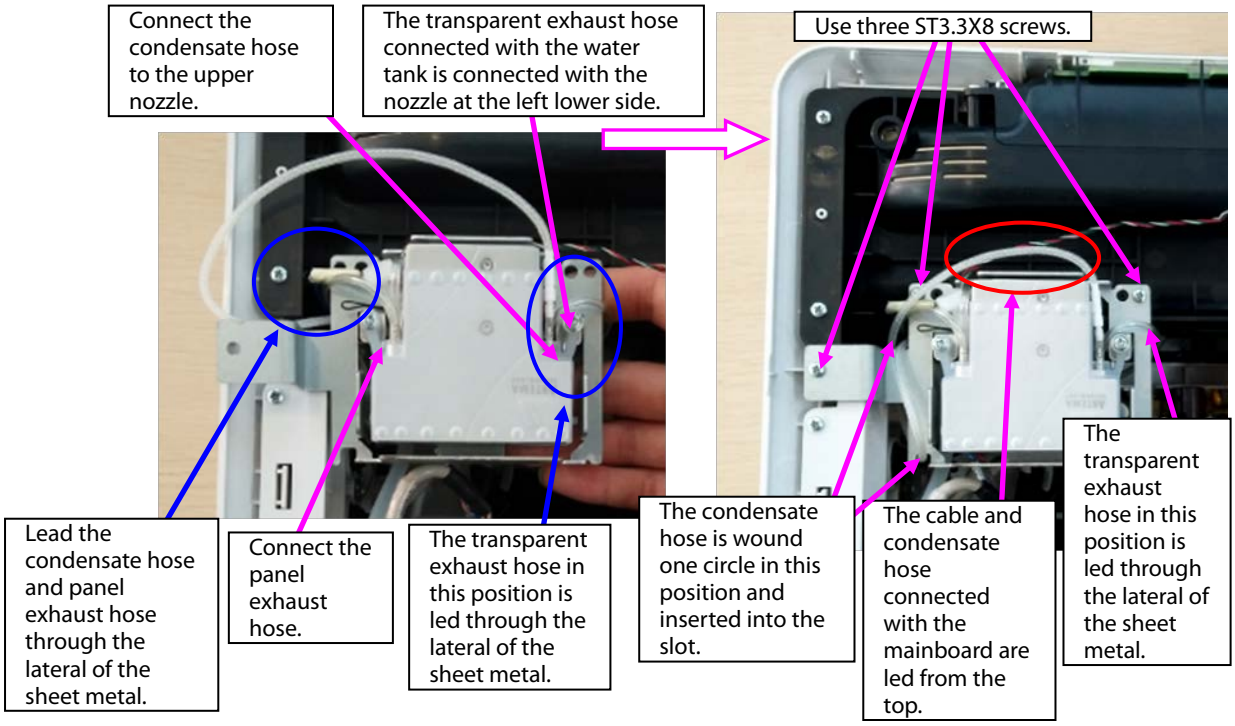
C. Disassemble the two PT2.0X6 screws on the panel water tank, and take the water tank out.



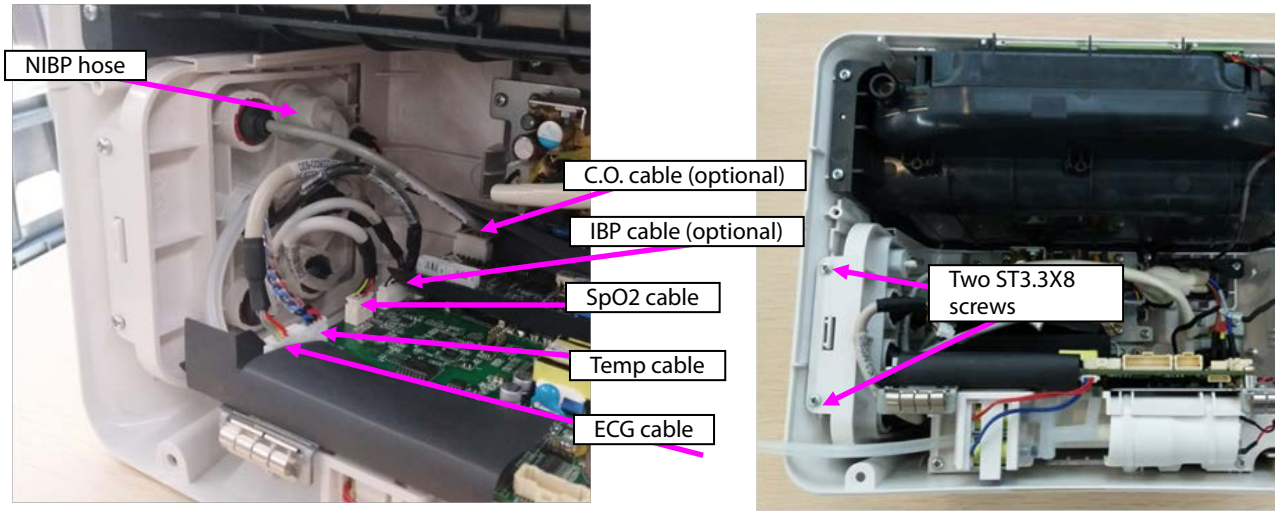




Note. During reassembly of the sidestream CO_2 module, follow the requirements below to perform assembly.



6. Remove the panel cable from the mainboard, and remove the NIBP exhaust hose.
7. Loosen two ST3.3X8 cross pan head tapping screws using the screwdriver, and take the panel fixing pin and panel component out.



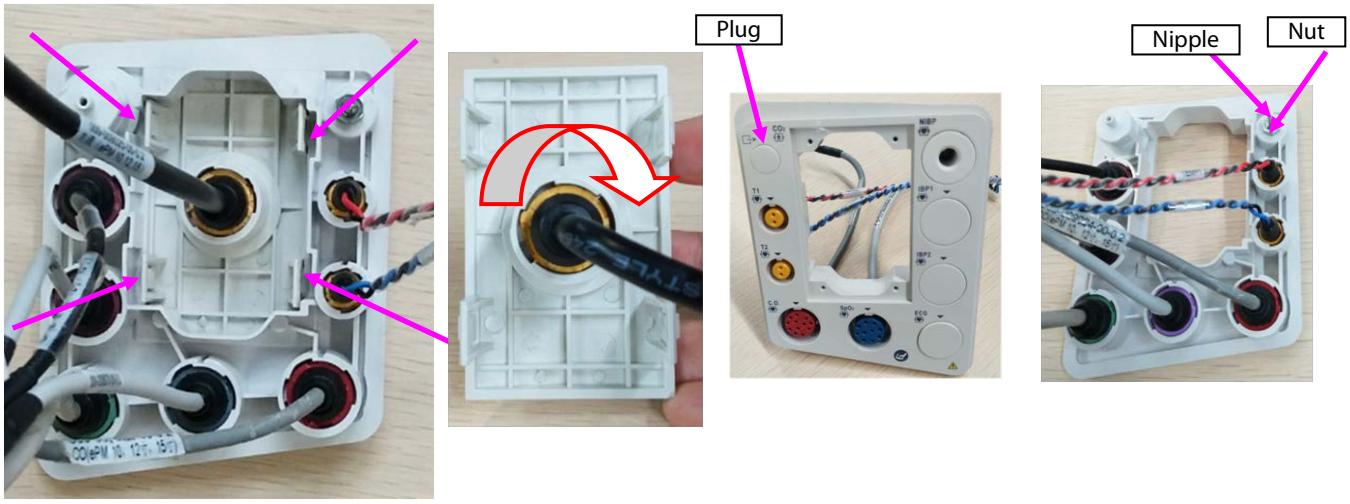
8. When a mainstream module is configured, disassemble the mainstream panel port.

A. Use pliers or tweezers to jack the fastener on the panel, and take the interface board out.

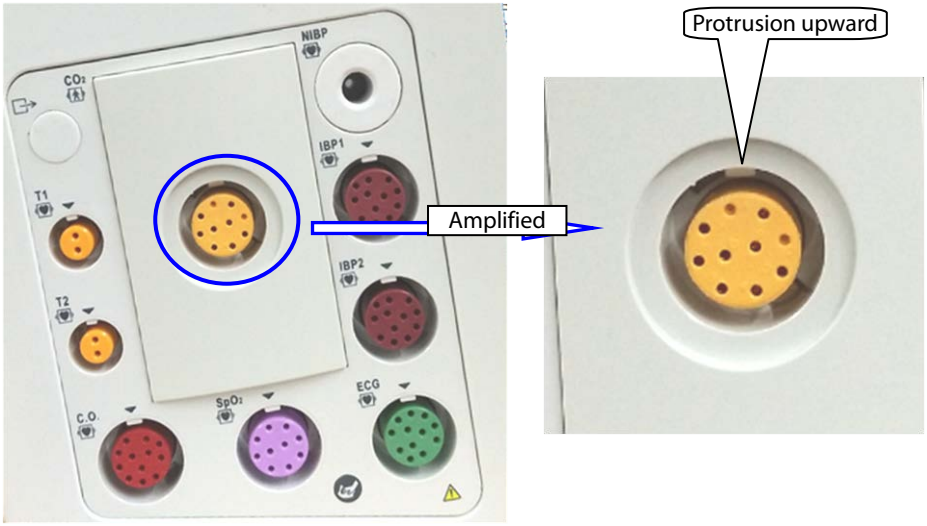
B. Rotate the cable anticlockwise, and remove the CO_2 cable.

C. Remove the plug from the panel.

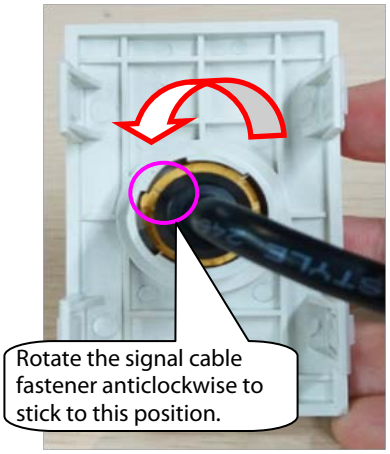
D. Loosen the M5 screw from the upper right corner of the panel, and take the nozzle out.



Note 1. During reassembly, the interface board of the mainstream panel should be in the following direction.



Note 2. During reassembly of the cable to the interface board, tighten it firmly anticlockwise.

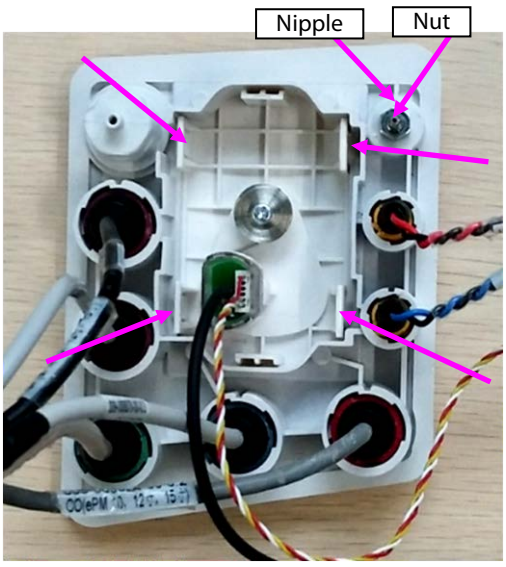


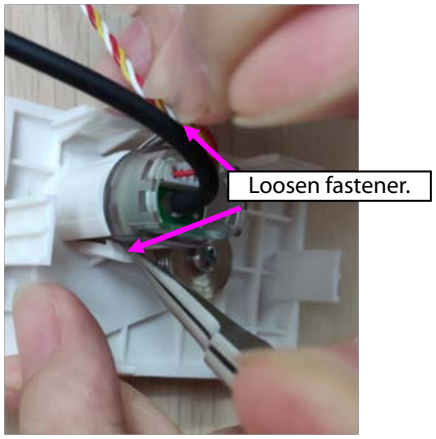
9. When an microstream module is configured, disassemble the microstream water tank.

A. Use pliers or tweezers to jack the fastener on the panel, and take the microstream water tank base out.

B. Loosen the M5 screw from the upper right corner of the panel, and take the exhaust nozzle out.

C. Use tweezers to loosen the fastener on the water tank base, and take the microstream connector out.





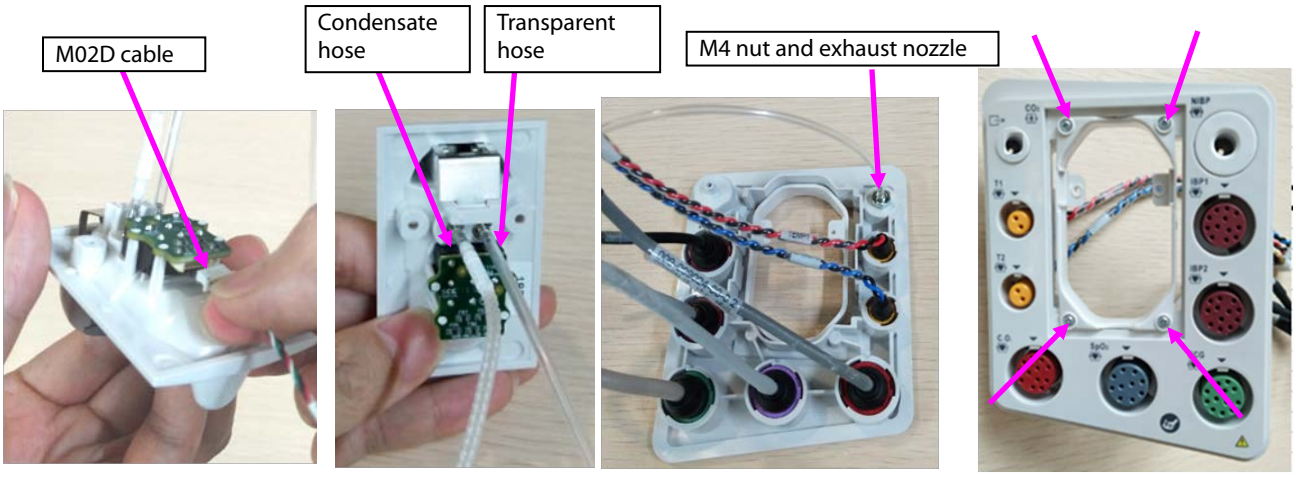
10. When a sidestream module is configured, disassemble the sidestream water tank.

A. Remove the cable or hose from the water tank.

B. Remove the exhaust hose from the panel, loosen the M4 screw on the exhaust nozzle, and take the nozzle out.

C. Loosen the M5 screw/M4 nut on the panel, and take the exhaust nozzle out.

D. Loosen the four PT2.0X6 screws on the panel, and take the bracket of the sidestream water tank out.



11. Disassemble the panel cable.

A. According to the figure, rotate different parameter cables anticlockwise, and remove them.

B. Take the arrival reminding shrapnel out.

Diagram (CO2 gas module is not used)

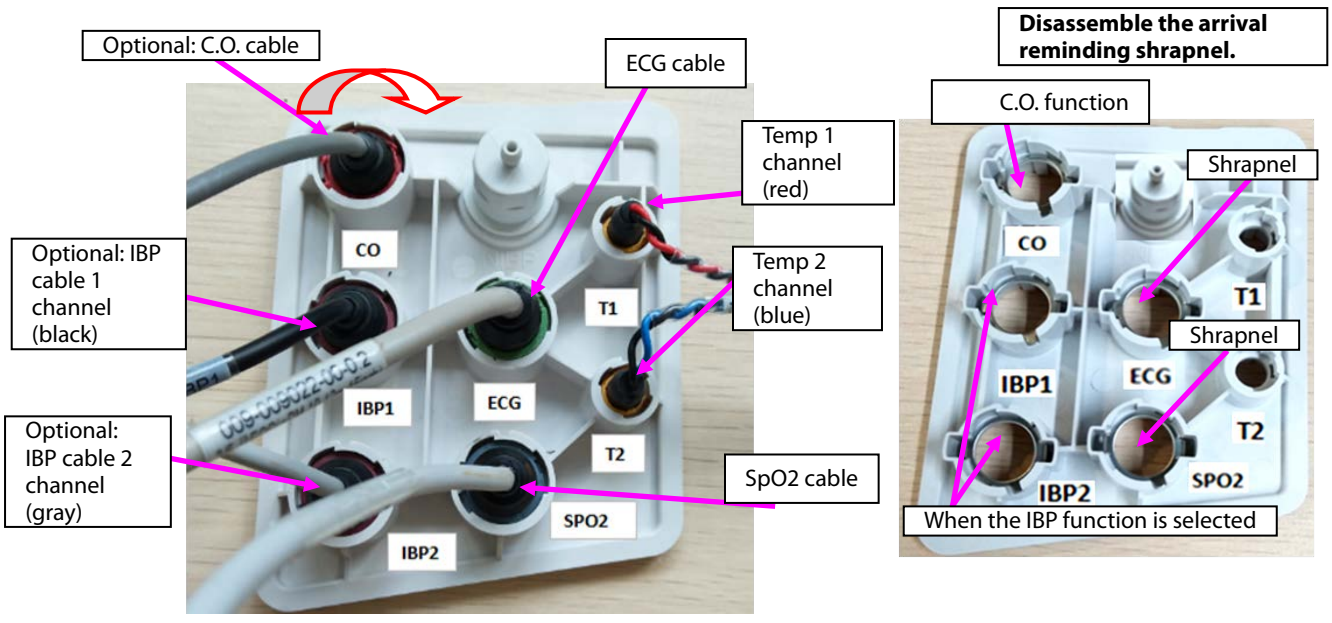
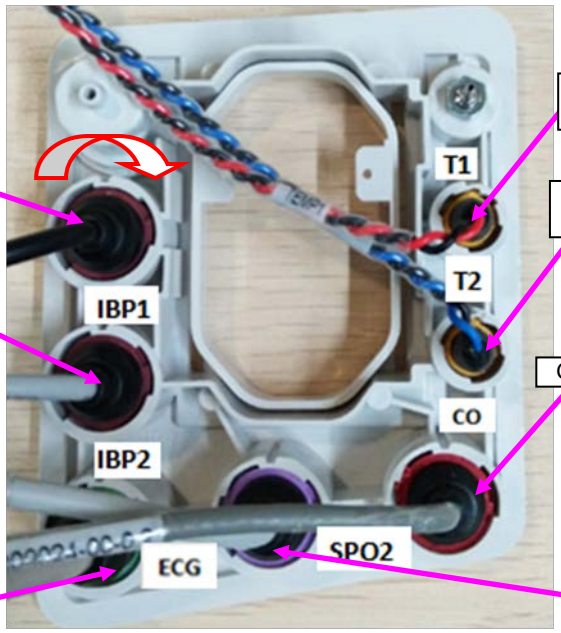


Diagram (CO2 gas module is used)



Optional: IBP cable 1 channel (black)

Optional: IBP cable 2 channel (gray)

ECG cable

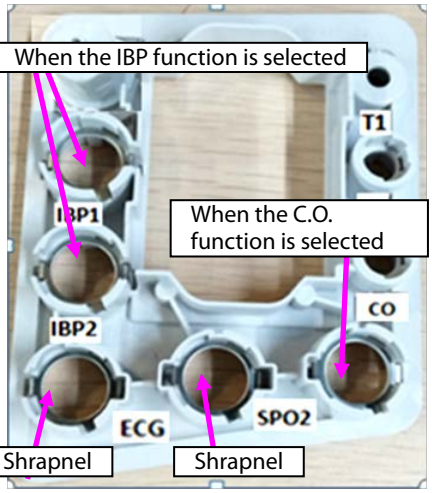
Temp 1 channel (red)

Temp 2 channel (blue)

Optional: C.O. cable

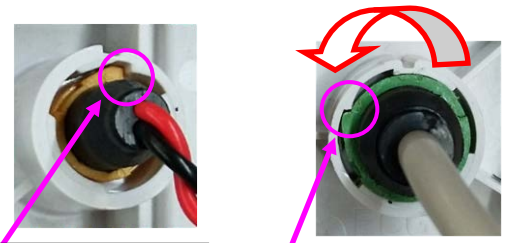
SpO2 cable

Disassemble the arrival reminding shrapnel.



Note. During reassembly, follow the requirements below to perform cable assembling.

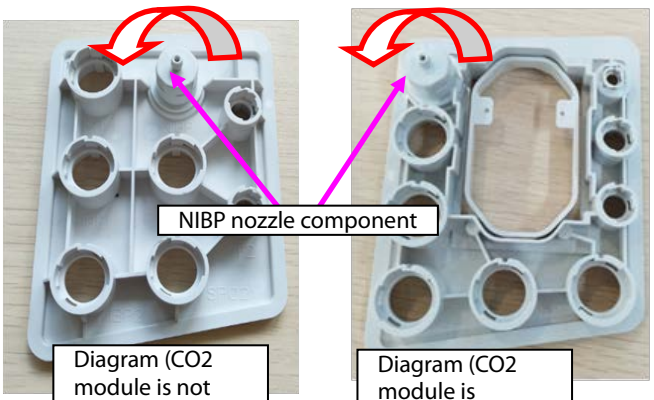
Cable connector assembly diagram



Rotate the temp socket anticlockwise and stick it to the locating slot.

Rotate other sockets anticlockwise and stick them to the locating slot.

12. Disassemble the NIBP nozzle: Rotate the NIBP nozzle anticlockwise, and disassemble the NIBP nozzle.



NIBP nozzle component

Diagram (CO2 module is not configured)

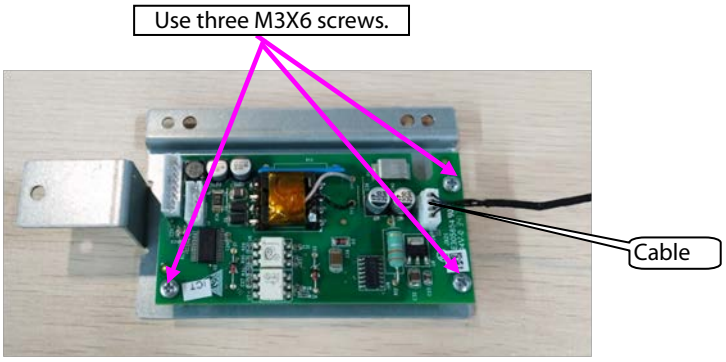
Diagram (CO2 module is configured)

7.5.5 Disassembling Gas Module

1. When mainstream CO_2 is configured:

A. Loosen the three M3X6 screws in the figure, and take the mainstream CO_2 isolation power board out.

B. Remove the cable connecting the mainstream isolation power board with the mainboard.



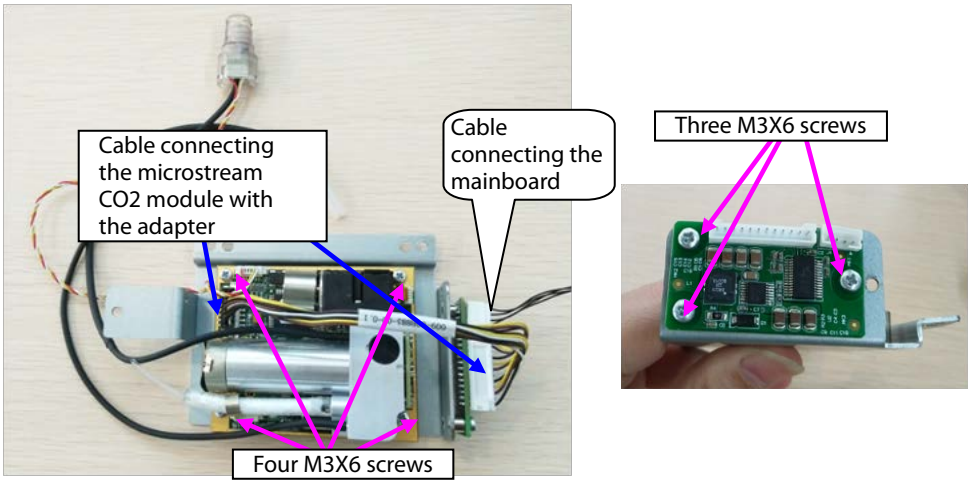
2. When microstream CO_2 is configured:

A. Remove the cable connecting the microstream CO_2 module with the adapter.

B. Remove the cable connecting the mainboard.

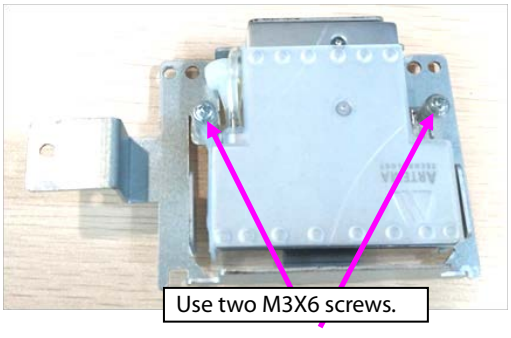
C. Loosen the four M3X6 screws in the figure, and take the microstream CO_2 module out.

D. Loosen the three M3X6 screws, and take the adapter out.



3. When sidestream CO_2 is configured:

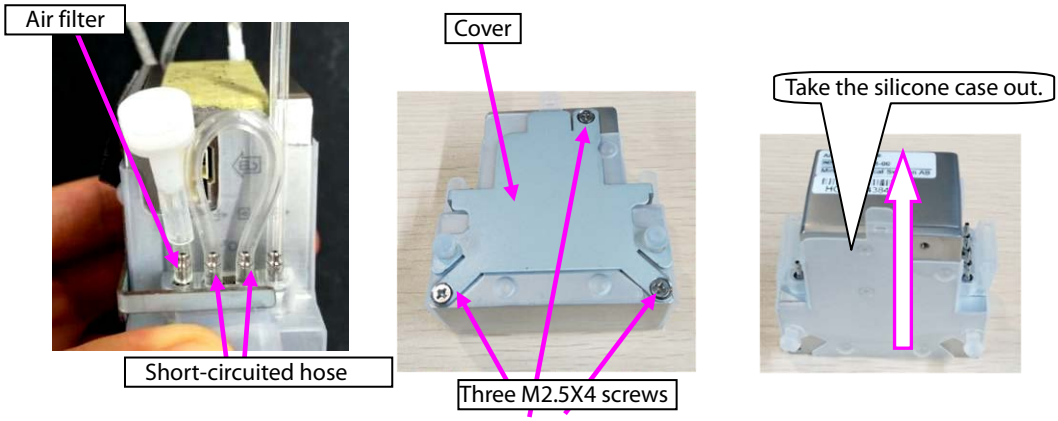
A. Loosen the two M3X6 screws in the figure, and take the sidestream gas module out.



B. Take the air filter and short-circuited hose out.

C. Loosen the three M2.5X4 countersunk screws, and take the cover out.

D. Take the silicone case out.

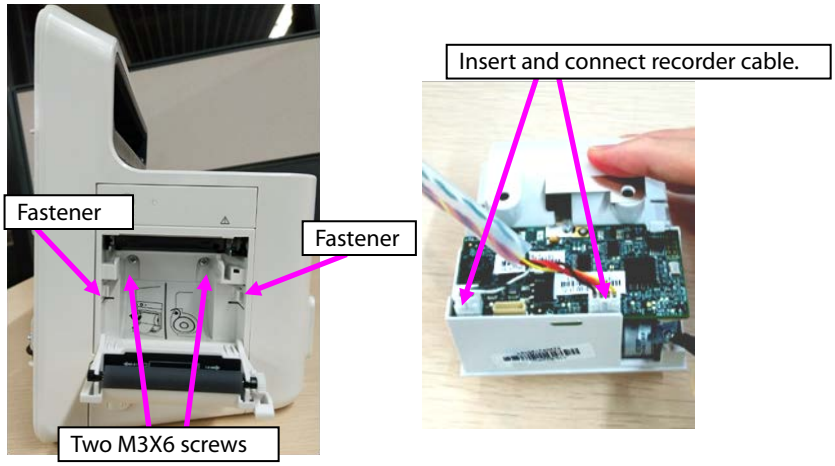


7.5.6 Disassembling Recorder/Recorder Bracket

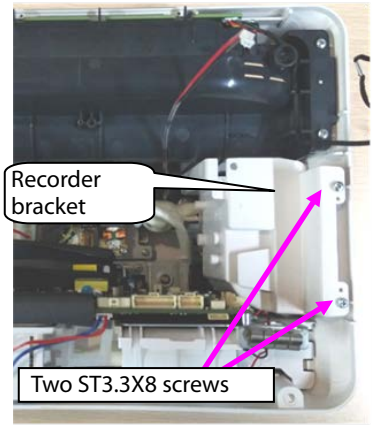
1. When the recorder is configured, disassemble the recorder:

A. Loosen the two M3X6 screws of the recorder, loosen the two fasteners of the recorder, and take the recorder out.

B. Remove the cable connecting the two sockets of the recorder.

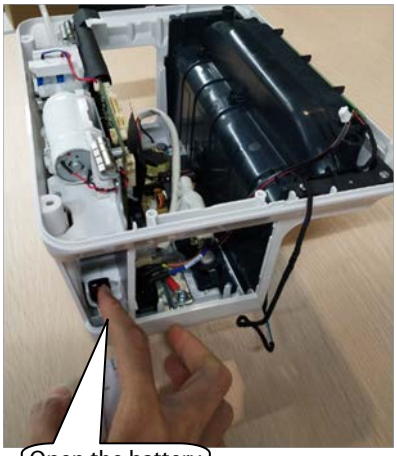


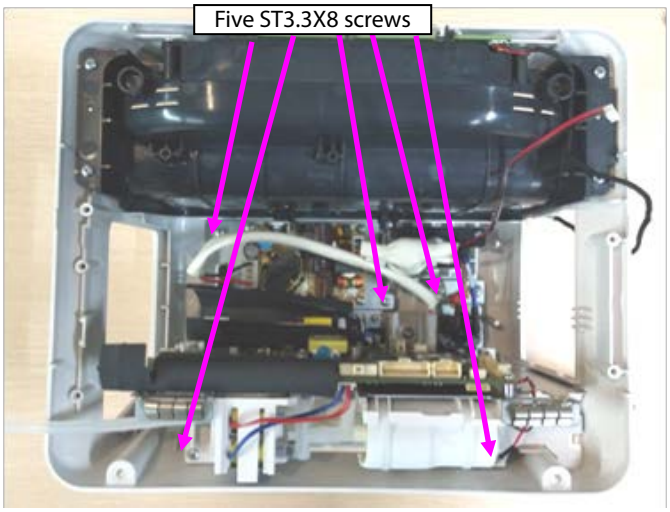
2. Take the recorder bracket out: Loosen the two ST3.3X8 screws on the recorder bracket, and take the recorder bracket out.



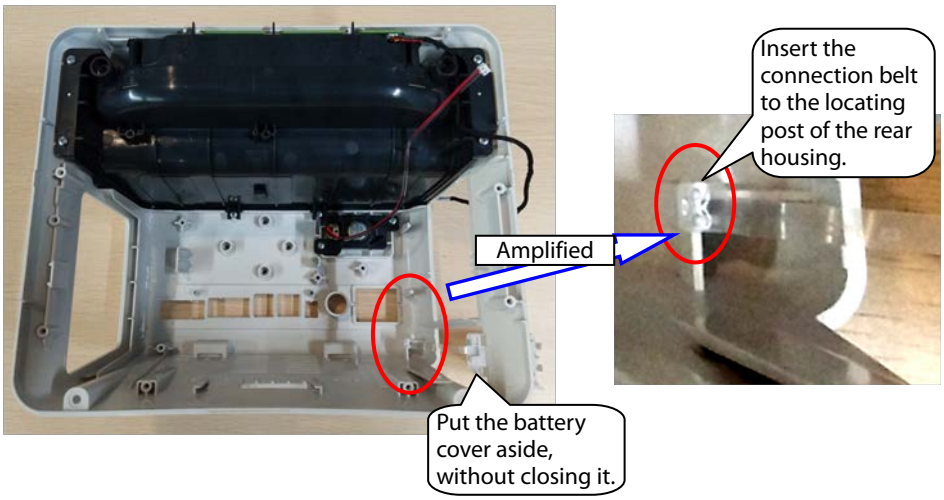
7.5.7 Disassembling Main Bracket Component

1. Loosen the battery cover.
2. Loosen the five ST3.3X8 screws shown in the figure, and remove the main bracket component.

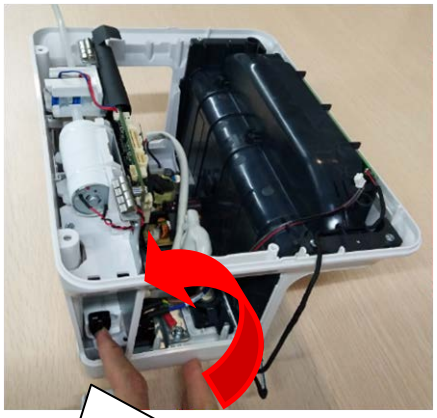




Note 1. Before reassembling the main bracket component, insert the connection belt of the battery cover to the locating post of the rear housing shown in the following figure.



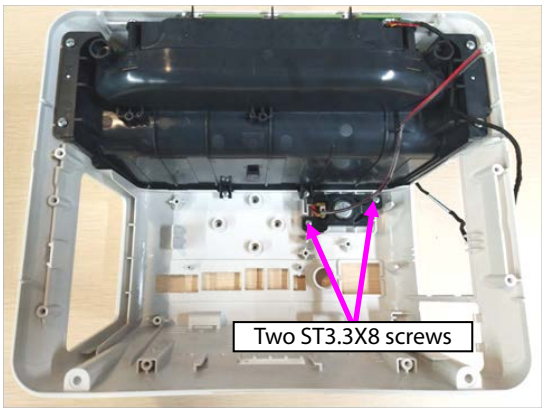
Note 2. Before closing the battery cover, switch the battery to the vertical position shown in the figure.



After the battery is switched to the vertical position, close the battery cover.

7.5.8 Disassembling Speaker

1. Loosen the two ST3.3X8 screws of the speaker component shown in the figure, and take the speaker component out.

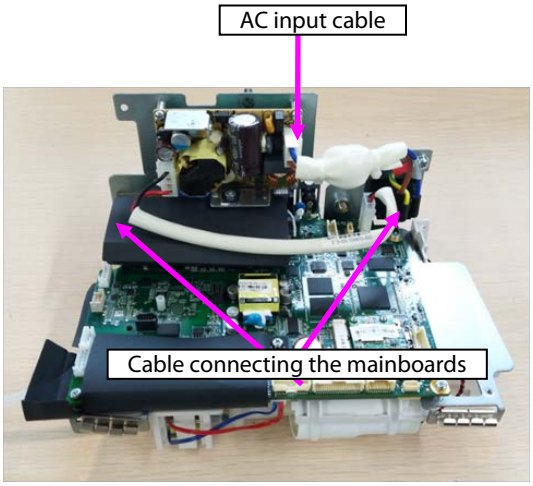


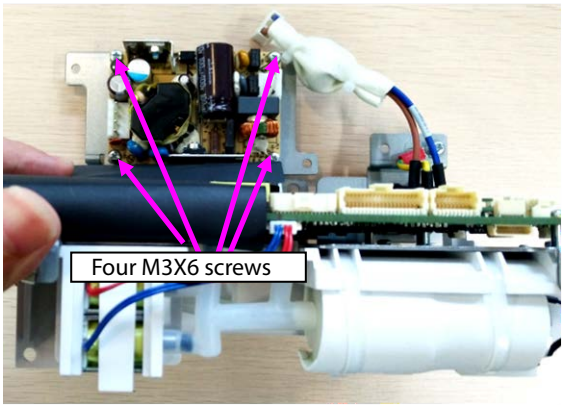
7.5.9 Disassembling Rear Alarm Indicator (Configured)

1. Loosen the six ST3.3X8 screws on the cover component shown in the figure, and take the top cover component out.
2. Loosen the one ST3.3X8 screw on the rear alarm indicator shown in the figure, and take the rear alarm indicator component out.

7.5.10 Disassembling Power Module

1. Remove the AC input cable, and remove the cable connecting the power module with mainboard out.
2. Loosen the four M3X6 screws of the power module, and take the power module out.

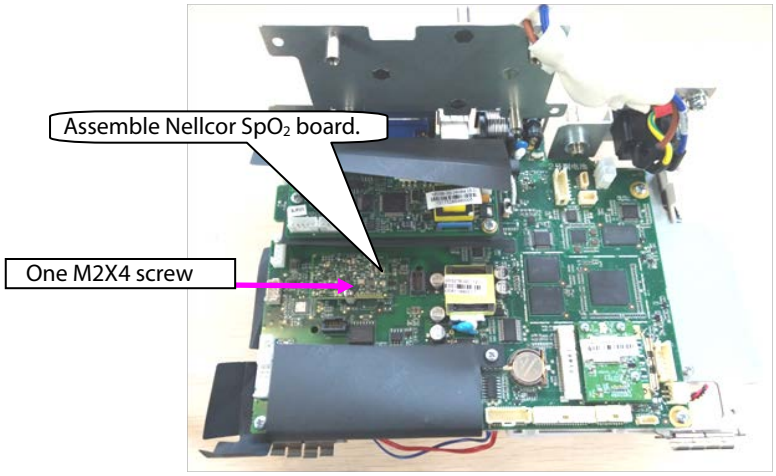




7.5.11 Disassembling SpO_2 Module (When Nellcor/Massimo SpO_2 Is Configured)

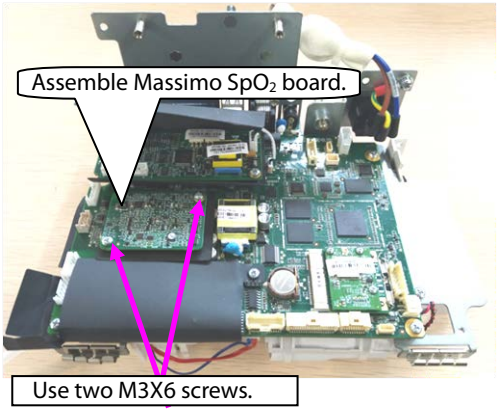
1. When Nellcor SpO_2 is configured:

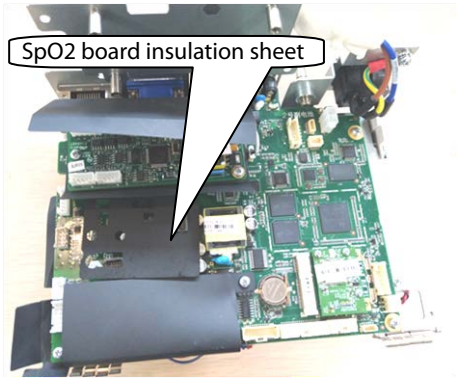
Loosen the one M2X4 screw on the Nellcor SpO_2, and take the Nellcor SpO_2 board out.



2. When Massimo SpO_2 is configured:

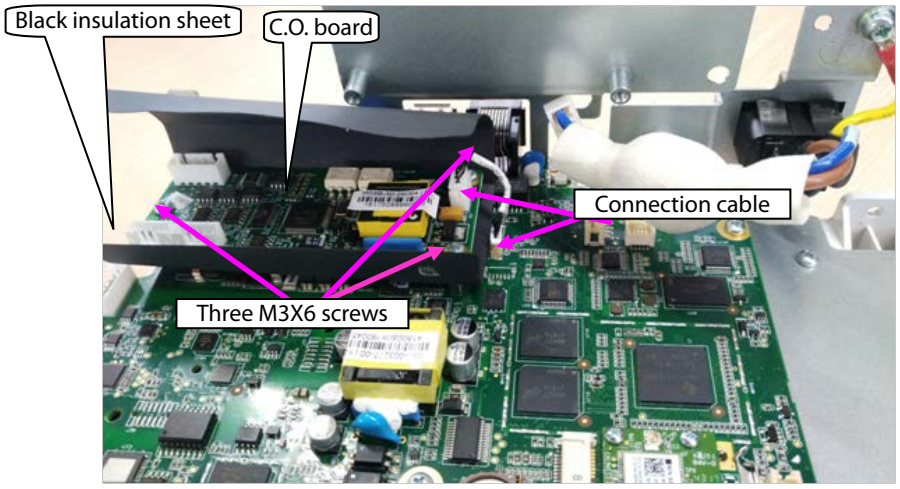
Loosen the two M2X4 screws on the Massimo SpO_2, and take the Massimo SpO_2 board and insulation sheet out.





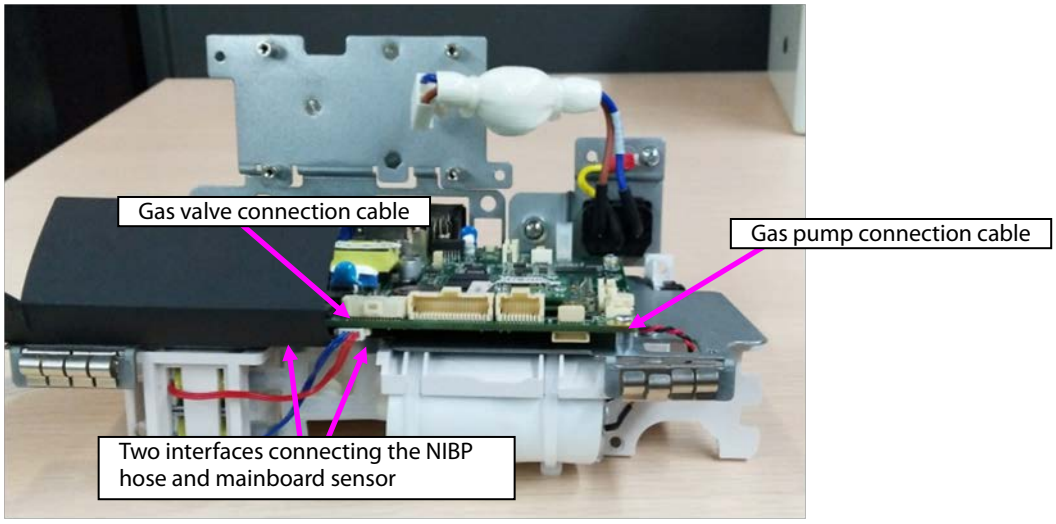
7.5.12 Disassembling C.O. Board (Configured)

1. Remove the cable connecting the C.O. board with the mainboard.
2. Loosen the two M3X6 screws on the Massimo SpO_2, and take the C.O. board and insulation sheet out.

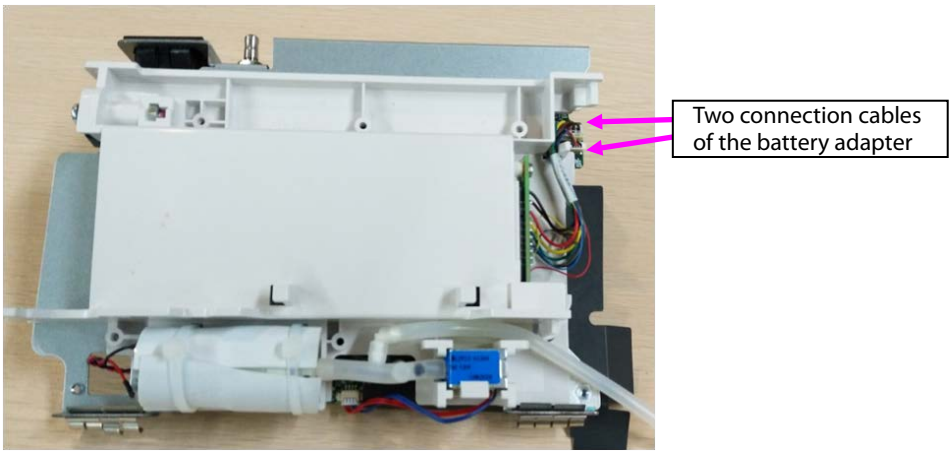


7.5.13 Disassembling Mainboard

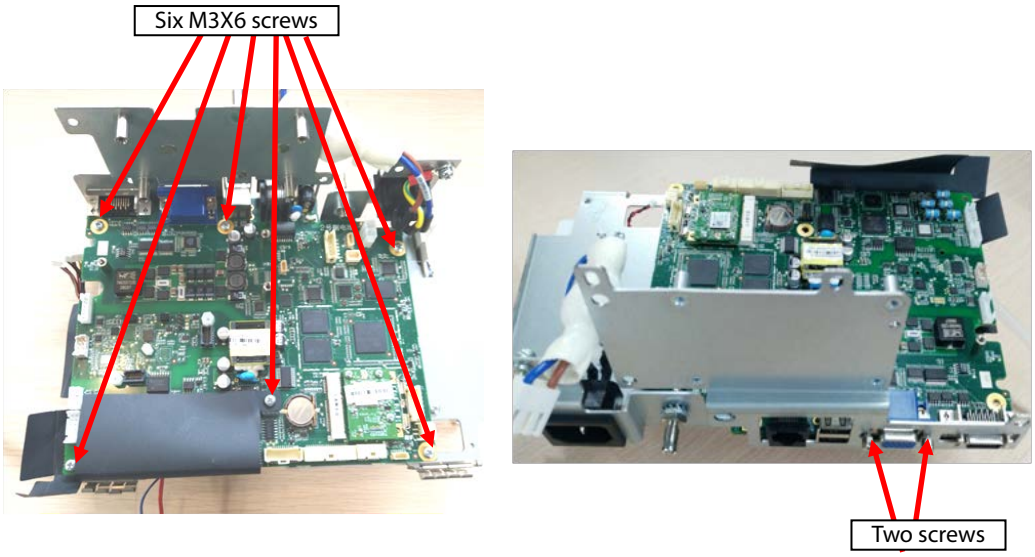
1. Remove the pump/valve connection cables from the mainboard.
2. Take the two interfaces of the NIBP hose from the mainboard sensor.



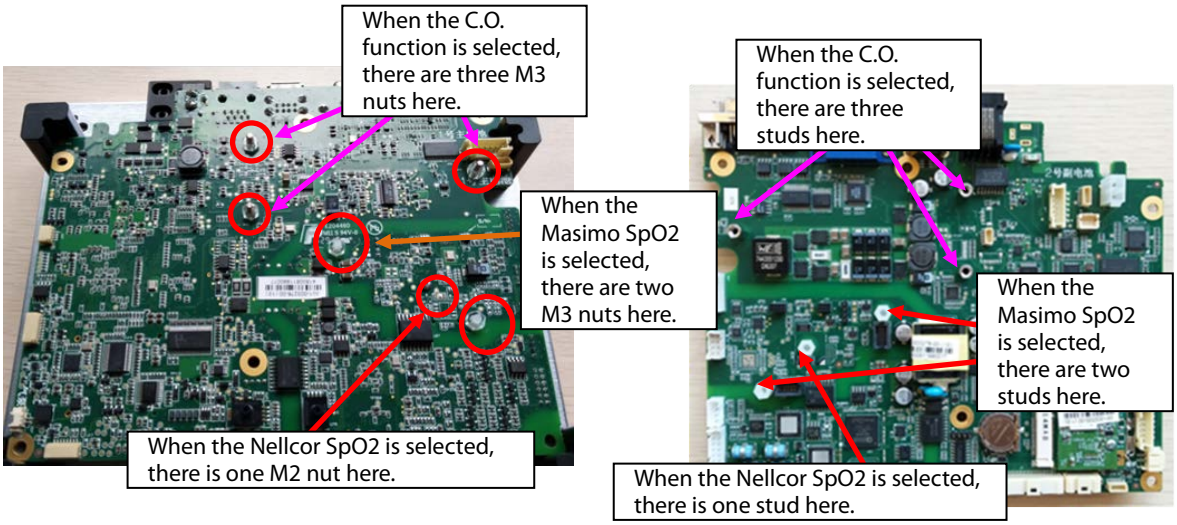
3. Remove the connection cable of the battery adapter from the mainboard.



4. Loosen the six M3X6 screws from the main bracket in the figure.
5. Loosen the two screws on the rear of the main bracket sheet metal, and take the mainboard out.

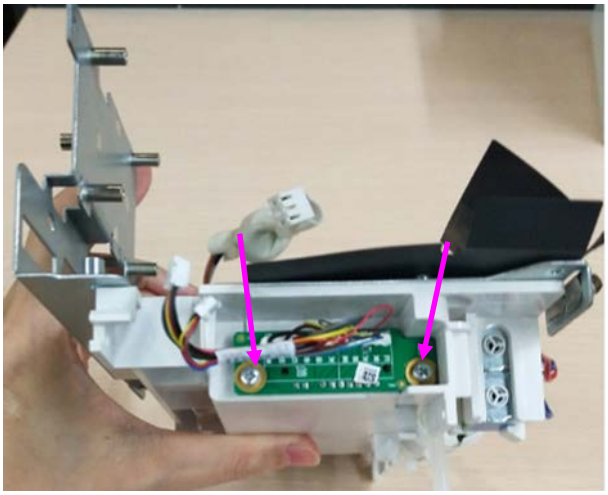


6. As shown in the following figure, loosen the nuts or screws on the rear of the mainboard, and take the studs out.

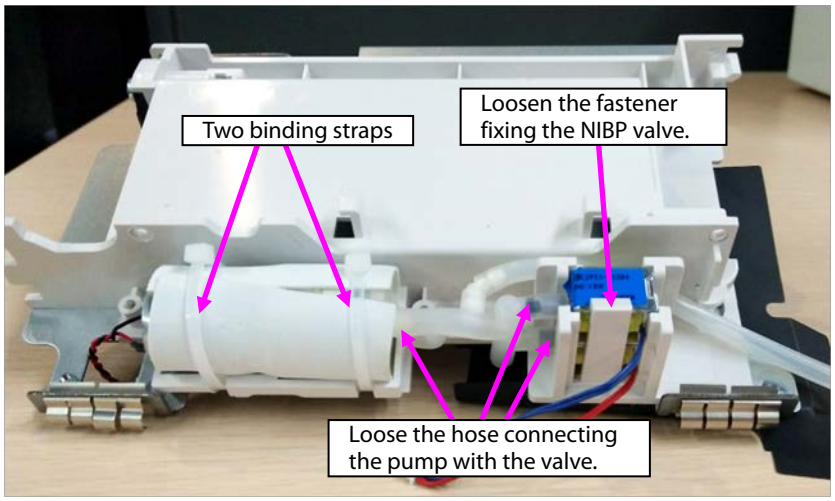


7.5.14 Disassembling Power Adapter and NIBP Pump/Valve

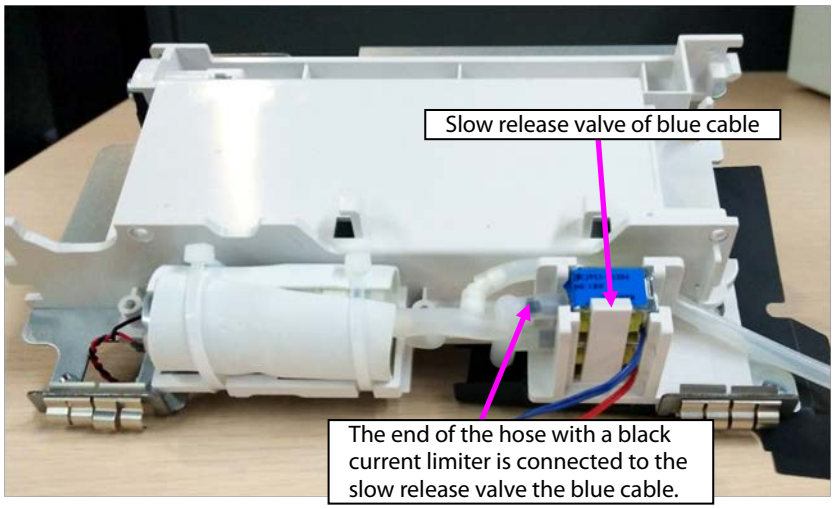
1. As shown in the following figure, loosen the two ST3.3X8 screws, and take the battery adapter out.



2. Loosen the hose connecting the NIBP pump/valve.
3. Loosen the fastener fixing the NIBP valve, and take the NIBP valve out.
4. Loosen the two binding straps fixing the NIBP pump, and take the NIBP pump out.



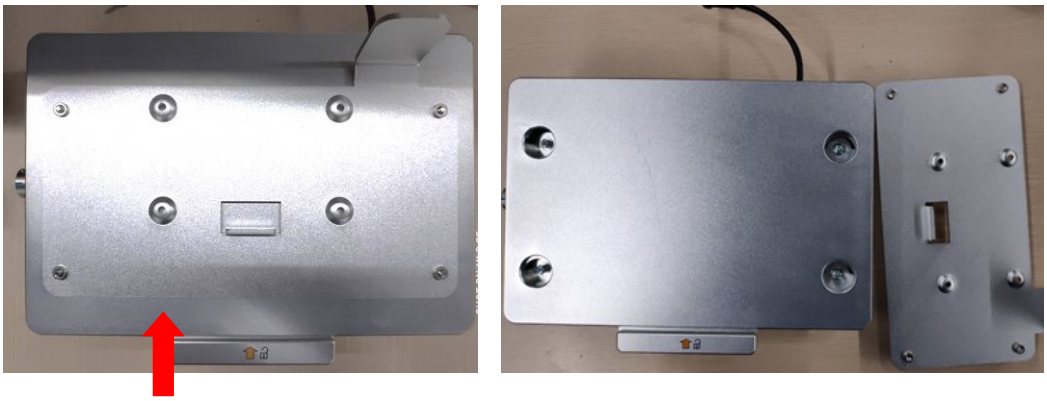
Note: During reassembly, ensure that the hose is correctly connected with the quick/slow release valve.



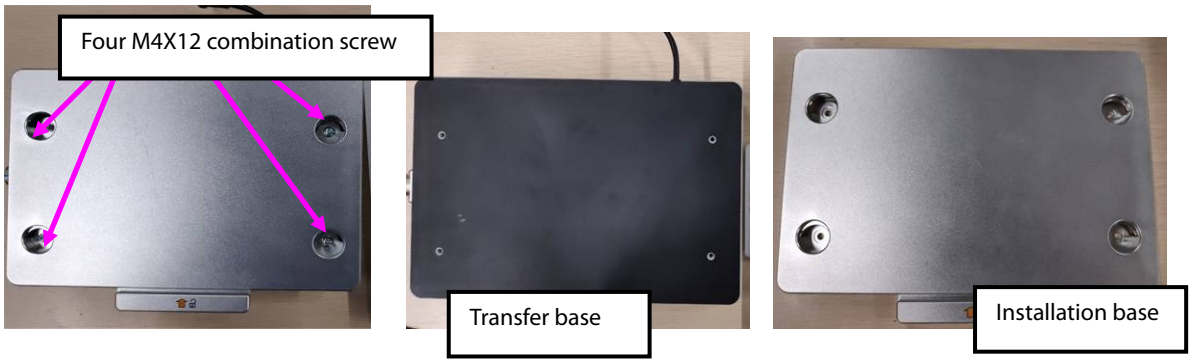
7.6 ePM T10 Vehicle-mounted Charger Base Disassembly

7.6.1 Disassembling Transfer Base

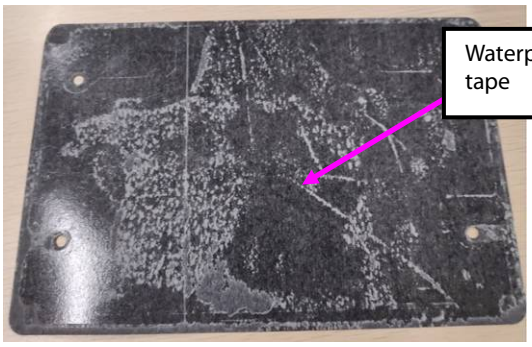
1. Push the release handle towards the arrow direction marked on the handle, and take the adapter component out upward.



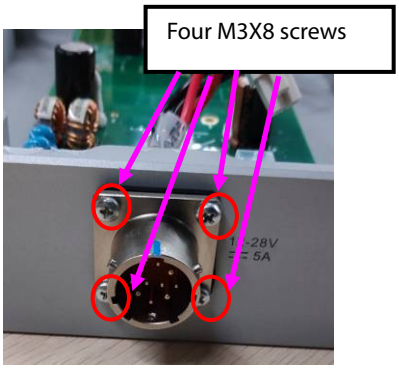
2. Loosen the four M4X12 combination screws using the Phillips screwdriver, and separate the transfer base from the installation base.



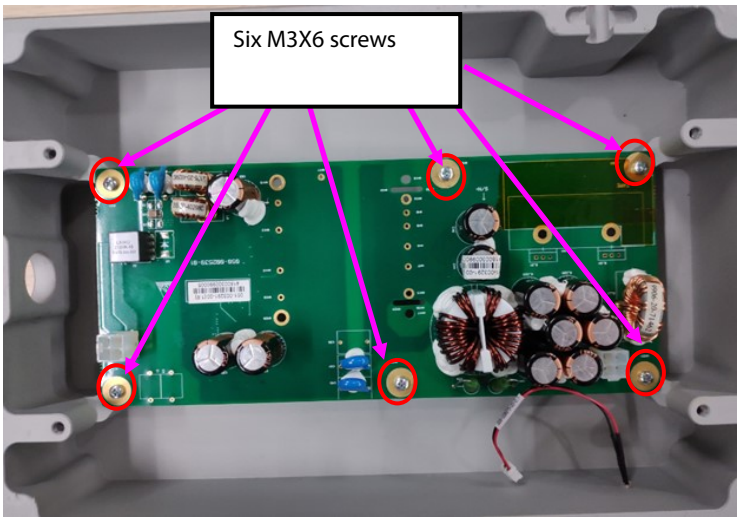
3. Use tweezers to peel the waterproof tape off. In case of reinstallation, use a new waterproof tape.



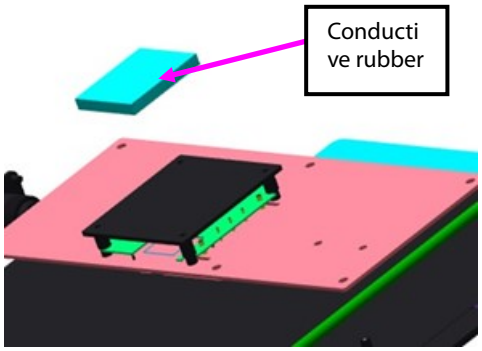
4. Remove the output cable from the PCBA base, and take the cable out. Remove the input cable terminal from the PCBA, loosen the four M3X8 screws, and take the power input connector out from the base.



5. Loose the six M3X6 screws using a Phillips screwdriver, remove the socket of the LED indicator from the PCBA, and take the PCBA out.

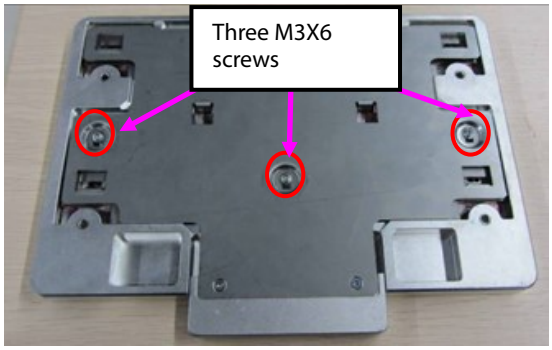


6. Use tweezers to take the conductive rubber of the PCBA from the cooling block, and pull the LED indicator out from the base hole.

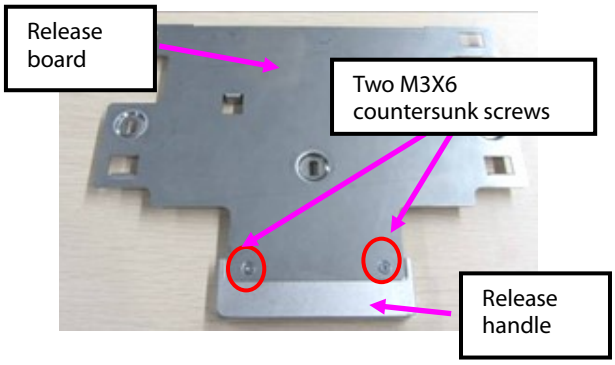


7.6.2 Disassembling Installation Base

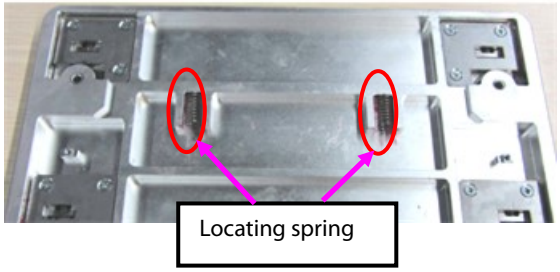
1. Use tweezers to peel the sealing tape off, and loosen the three M3X6 pan head screws with pad using the screwdriver.

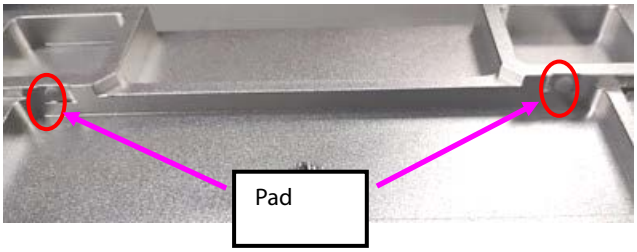


2. Take the release board and release handle out upward, loosen the two M3X6 countersunk screws using the screwdriver, and separate the release board from the release handle.

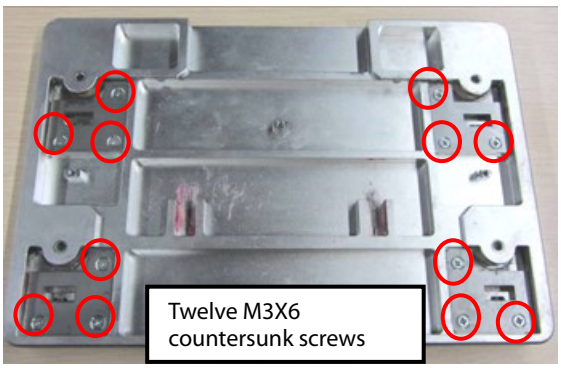


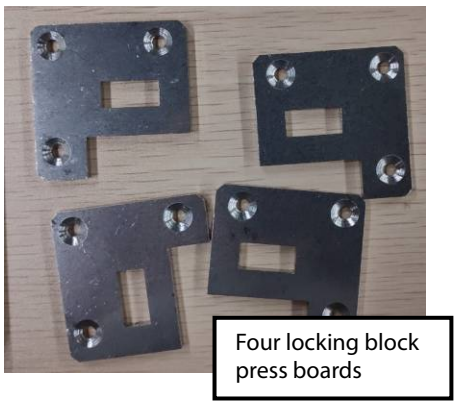
3. Take the two locating springs out, and use the tweezers to remove the two pads.



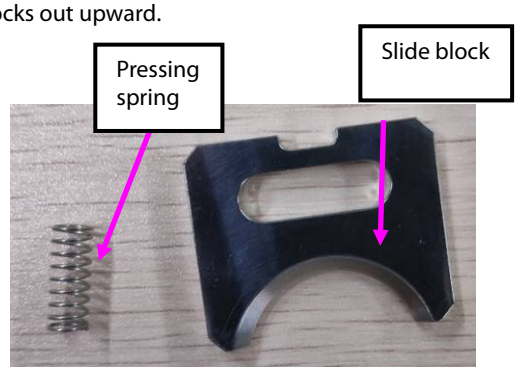


4. Loosen the twelve M3X6 countersunk screws using the screwdriver, and remove the four locking block press boards.



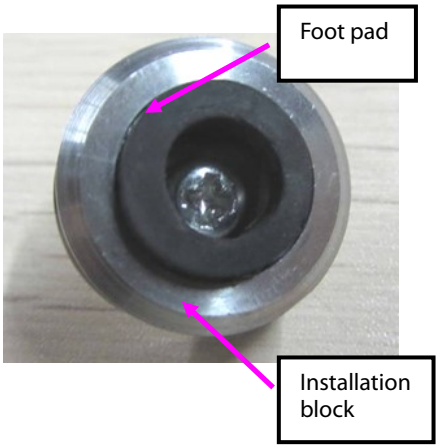


5. Take the four pressing springs and slide blocks out upward.



7.6.3 Disassembling Adapter Component

Use tweezers to take the four foot pads out from the adapter component, and loosen the four M4X10 screws using the screwdriver, and separate the installation block from the adapter.



FOR YOUR NOTES

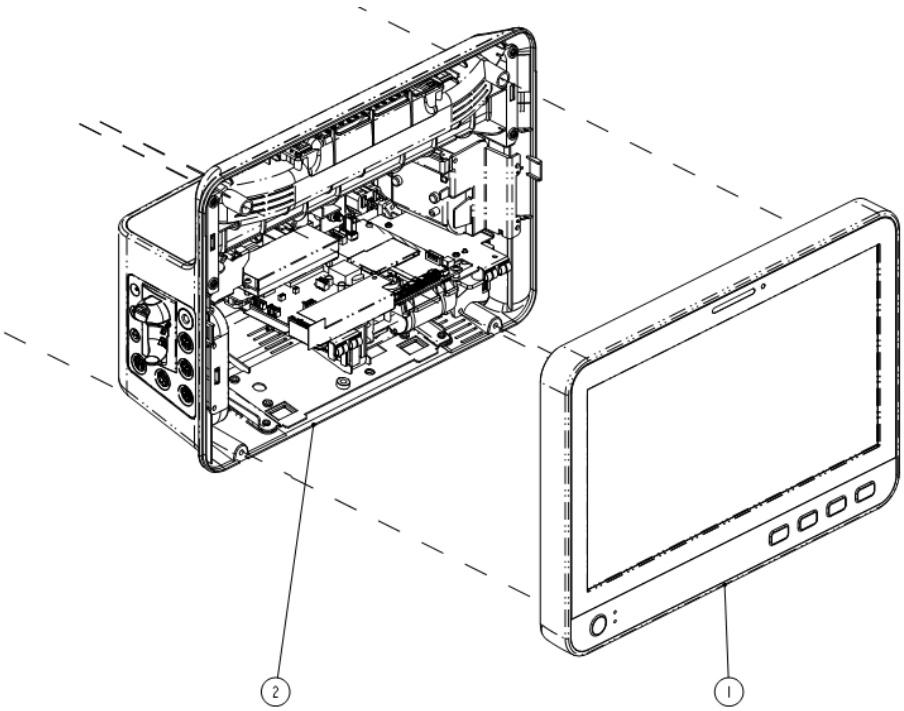
8 Parts

This part lists the exploded view and PN of the monitor, auxiliary plugin box and parameter module, so that maintenance personnel can recognize the names of different parts when they disassemble or replace the parts.

8.1 ePM 15/ePM 15A/ePM 15C Parts

8.1.1 System Structure

Exploded View

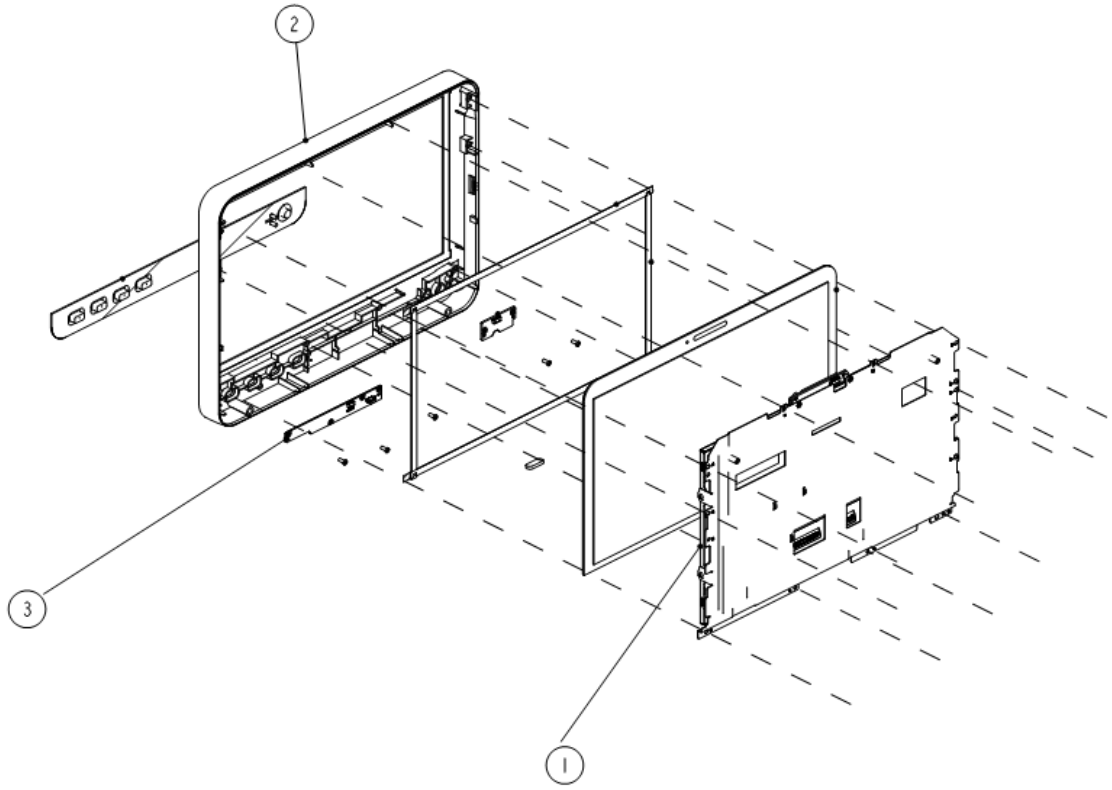


Parts List

No.	Name and Specification	Quantity	PN
1	Front Housing Assembly	1	115-060001-00
2	Repair kit for integrated 15-inch rear housing component (rear alarm light is not supported)	1	115-059949-00
	Repair kit for integrated 15-inch rear housing component (rear alarm light is supported)	1	115-059950-00

8.1.2 Front Housing

Exploded View

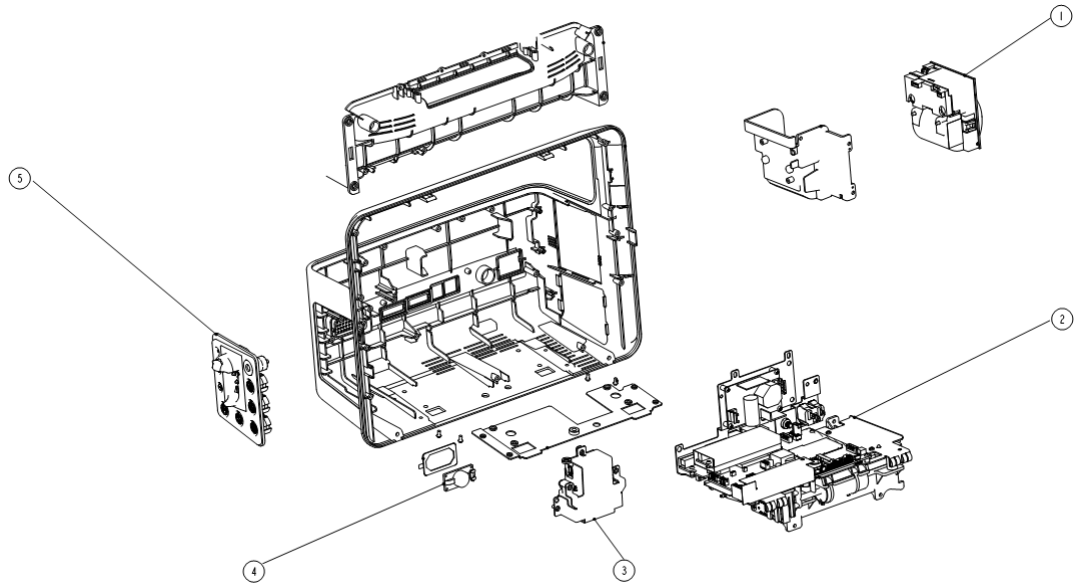


Parts List

No.	Name and Specification	Quantity	PN
1	TFT displayer assembly (AUO 15-inch screen)	1	115-059826-00
2	Repair kit for front housing and touch screen	1	115-060001-00
3	9202 C15 function keypad PCBA	1	115-059768-00

8.1.3 Rear Housing

Exploded View



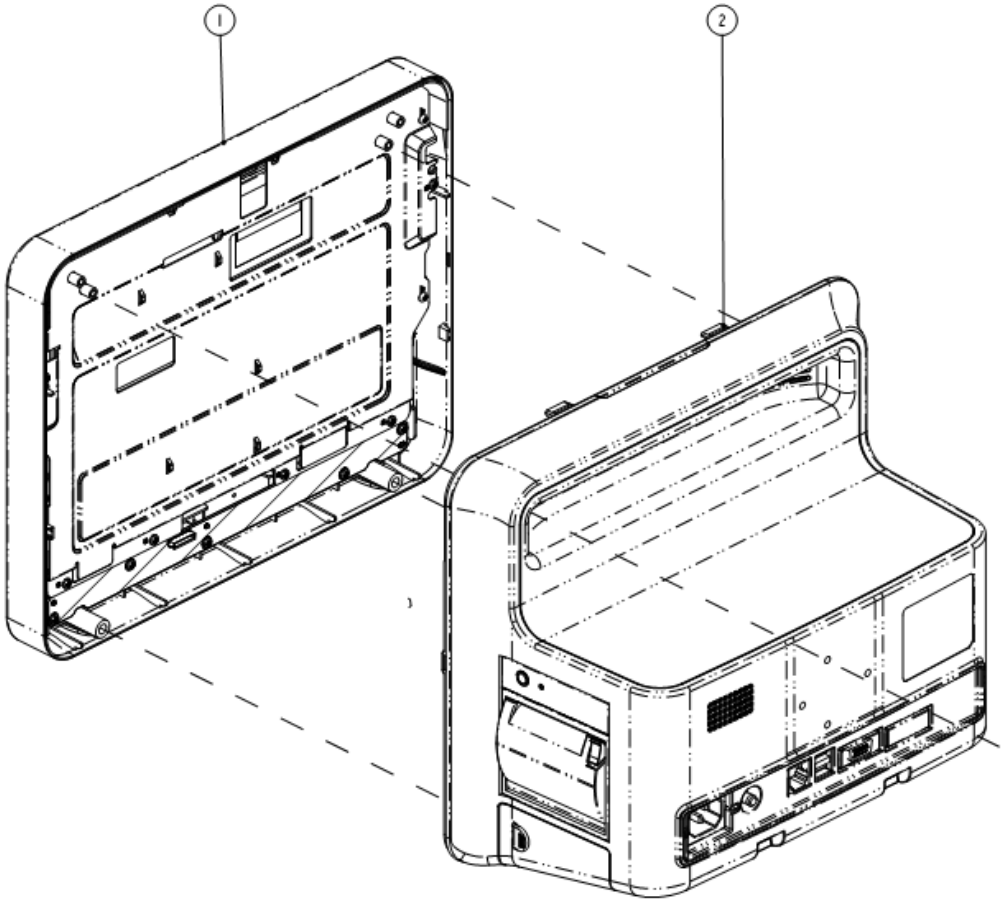
Parts List

No.	Name and Specification	Quantity	PN
1	TR6F recorder	1	115-059807-00
2	Integrated 15-inch standard configuration mainboard FRU (with software)	1	115-059942-00
	Integrated 15-inch full configuration 3/5-lead MR SpO_2 mainboard FRU (with software)	1	115-059943-00
	Integrated 15-inch full configuration 3/5-lead OEM SpO_2 mainboard FRU (with software)	1	115-059944-00
	Integrated 15-inch full configuration 12-lead MR SpO_2 mainboard FRU (with software)	1	115-059945-00
	Integrated 15-inch full configuration 12-lead OEM SpO_2 mainboard FRU (with software)	1	115-059946-00
3	Mindray sidestream CO_2 module kit	1	115-059955-00
4	Speaker 2W40hm 500Hz	1	115-059960-00
5	Repair kit for integrated panel component (CO_2 is not supported)	1	115-059951-00
	Repair kit for integrated panel component (CO_2 is supported)	1	115-059952-00

8.2 ePM 12/ePM 12A/ePM 12C Parts

8.2.1 System Structure

Exploded View

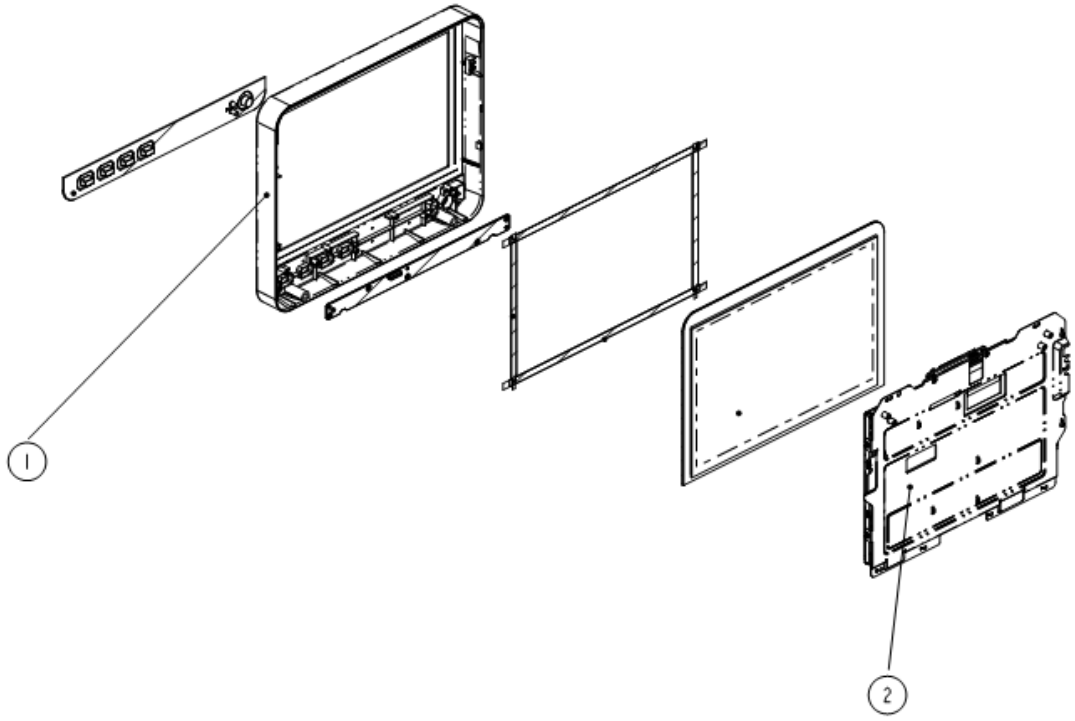


Parts List

No.	Name and Specification	Quantity	PN
1	Front Housing Assembly	1	115-059976-00
2	Repair kit for integrated 12-inch rear housing component (rear alarm light is not supported)	1	115-059972-00
	Repair kit for integrated 12-inch rear housing component (rear alarm light is supported)	1	115-059973-00

8.2.2 Front Housing

Exploded View

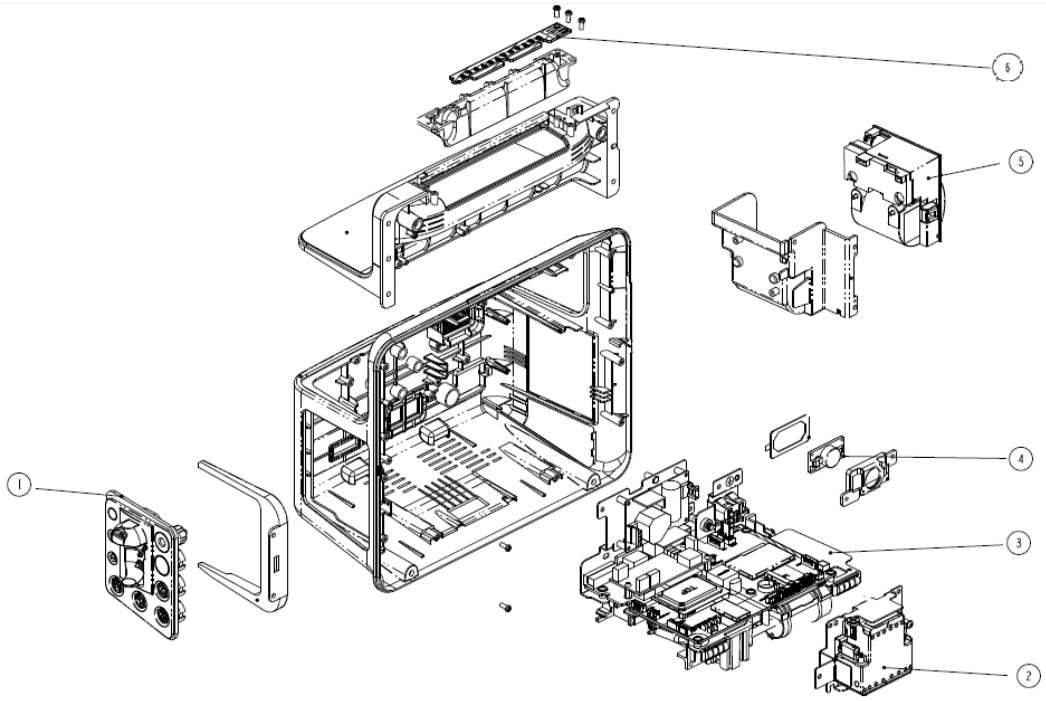


Parts List

No.	Name and Specification	Quantity	PN
1	Front Housing repair kit	1	115-059976-00
2	TFT display assembly (Innolux 12-inch screen)	1	115-059827-00

8.2.3 Rear Housing

Exploded View



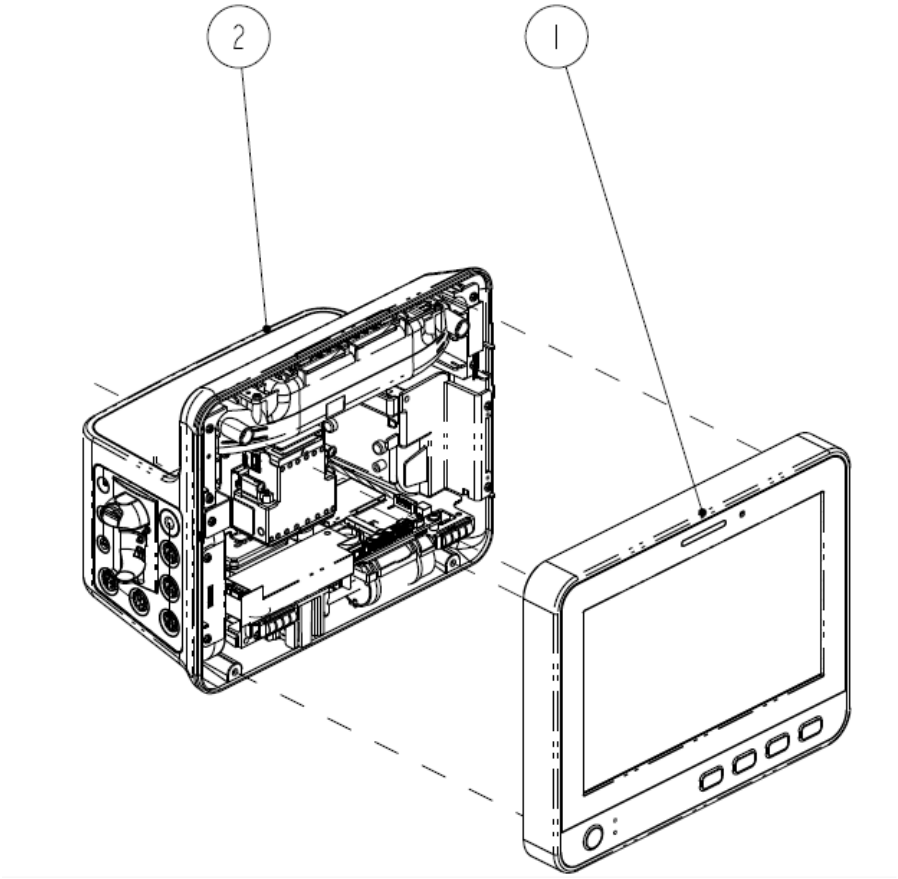
Parts List

No.	Name and Specification	Quantity	PN
1	Repair kit for integrated panel component (CO_2 is not supported)		115-059951-00
	Repair kit for integrated panel component (CO_2 is supported)		115-059952-00
2	CO_2 module (M02D)	1	115-059974-00
3	Integrated 12-inch standard configuration mainboard FRU (with software)	1	115-059965-00
	Integrated 12-inch full configuration 3/5-lead MR SpO_2 mainboard FRU (with software)	1	115-059966-00
	Integrated 12-inch full configuration 3/5-lead OEM SpO_2 mainboard FRU (with software)	1	115-059967-00
	Integrated 12-inch full configuration 12-lead MR SpO_2 mainboard FRU (with software)	1	115-059968-00
	Integrated 12-inch full configuration 12-lead OEM SpO_2 mainboard FRU (with software)	1	115-059969-00
4	Speaker repair kit	1	115-059830-00
5	TR6F recorder	1	115-059807-00
6	9202 rear alarm indicator PCBA	1	115-059941-00

8.3 ePM 10/ePM 10A/ePM 10C Parts

8.3.1 System Structure

Exploded View

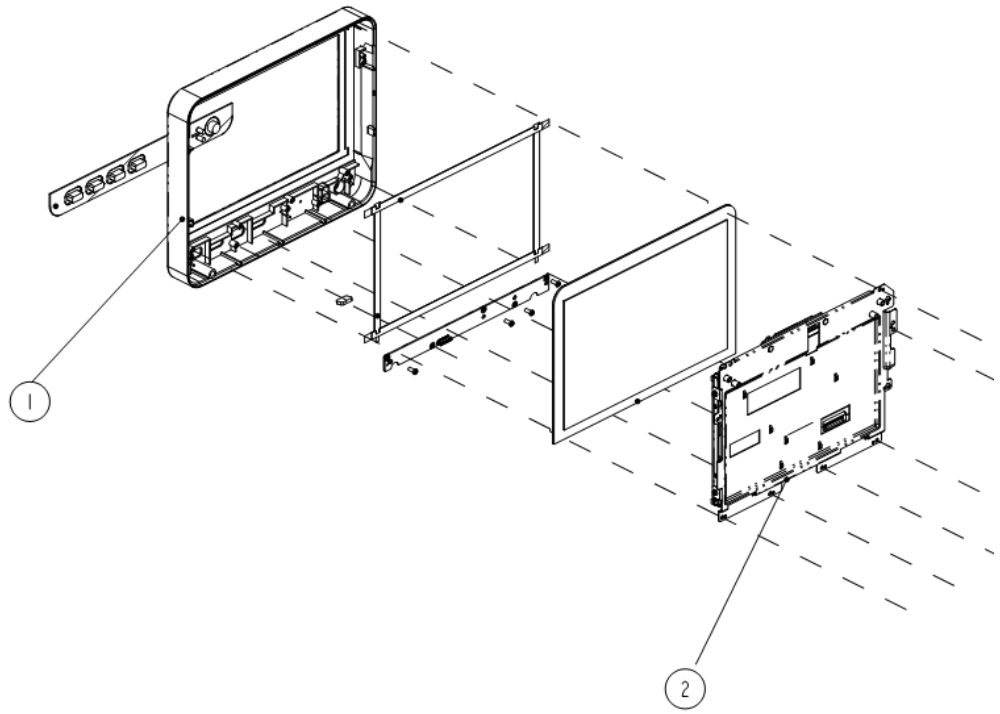


Parts List

No.	Name and Specification	Quantity	PN
1	Repair kit for front housing and touch screen (DC-in is not supported)	1	115-059997-00
	Repair kit for front housing and touch screen (DC-in is supported)	1	115-059998-00
2	Repair kit for integrated 10-inch rear housing component (rear alarm light is not supported)	1	115-059993-00
	Repair kit for integrated 10-inch rear housing component (rear alarm light is supported)	1	115-059994-00

8.3.2 Front Housing

Exploded View

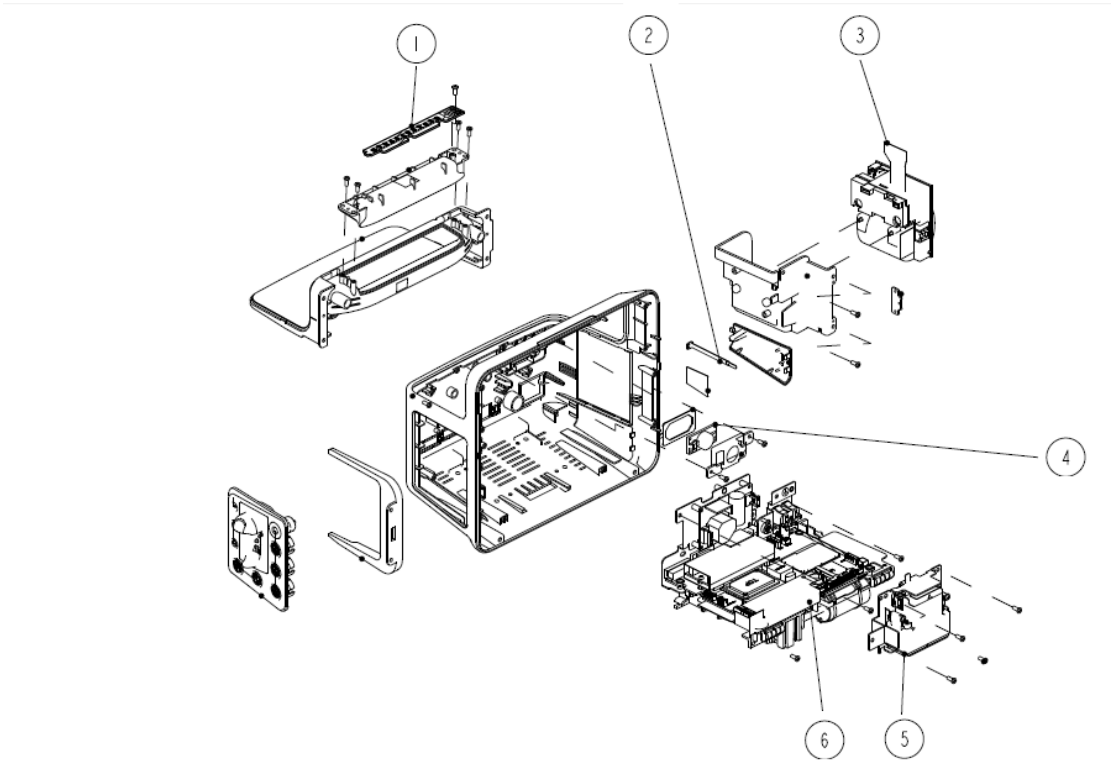


Parts List

No.	Name and Specification	Quantity	PN
1	Repair kit for front housing and touch screen	1	115-059997-00
2	TFT display assembly (Innolux 10-inch screen)	1	115-059828-00

8.3.3 Rear Housing

Exploded View



Parts List

No.	Name and Specification	Quantity	PN
1	Repair kit for front alarm light board (light sensor is not supported)	1	115-059746-00
	Repair kit for front alarm light board (light sensor is supported)	1	115-059747-00
2	ePM battery cover connection belt	1	043-010075-00
3	TR6F recorder	1	115-059807-00
4	Speaker	1	115-059830-00
5	CO_2 module (M02D)	1	115-059974-00
6	Integrated 10-inch standard configuration mainboard FRU (with software)	1	115-059985-00
	Integrated 10-inch full configuration 3/5-lead MR SpO_2 mainboard FRU (with software, DC-in is not supported)	1	115-059986-00
	Integrated 10-inch full configuration 3/5-lead OEM SpO_2 mainboard FRU (with software, DC-in is not supported)	1	115-059987-00

No.	Name and Specification	Quantity	PN
	Integrated 10-inch full configuration 3/5-lead MR SpO_2 mainboard FRU (with software, DC-in is supported)	1	115-059988-00
	Integrated 10-inch full configuration 3/5-lead OEM SpO_2 mainboard FRU (with software, DC-in is supported)	1	115-059989-00

A Electrical Safety Inspection

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

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

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

A.1 Power Cord Plug

A.1.1 The Power Plug

Test Item		Acceptance Criteria
The power plug	The power plug pins	No broken or bent pin. No discolored pins.
	The plug body	No physical damage to the plug body.
	The strain relief	No physical damage to the strain relief. No plug warmth for device in use.
	The power plug	No loose connections.
The power cord		No physical damage to the cord. No deterioration to the cord.
		For devices with detachable power cords, inspect the connection at the device.
		For devices with non-detachable power cords, inspect the strain relief at the device.

A.2 Device Enclosure and Accessories

A.2.1 Visual Inspection

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

A.2.2 Contextual Inspection

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

A.3 Device Labeling

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

- Main unit label
- Integrated warning labels

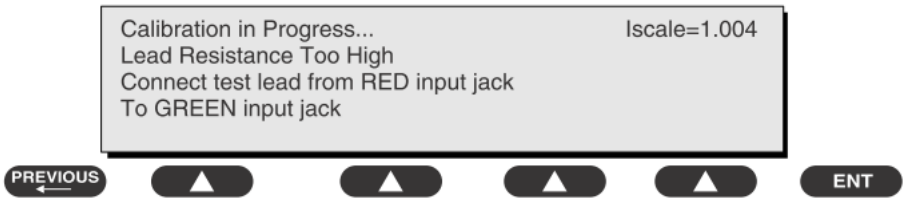
A.4 Protective Earth Resistance

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

The following conditions apply: L1 and L2 Open.

Preparation

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



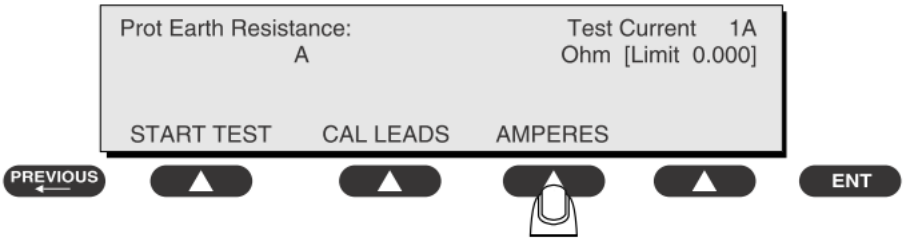
If the calibration fails, the previously stored readings will be used until a passing calibration has occurred.:

⚠WARNING

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

To Perform the Test

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



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

NOTE

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

In Case of Failure

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

LIMITS

ALL COUNTRIES R = 0.2 Ω Maximum

A.5 Earth Leakage Test

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

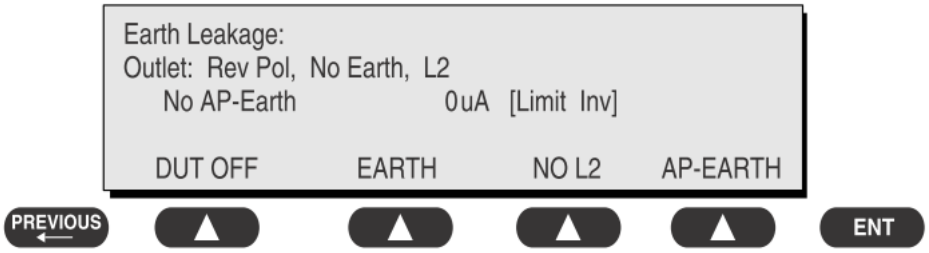
Leakage current is measured the following ways:

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

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

To Perform the Test

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



- SOFT KEY 1 toggles the DUT outlet Polarity from Normal to Off to Reverse.

- SOFT KEY 2 toggles the DUT outlet from Earth to No Earth.
- SOFT KEY 3 toggles the DUT outlet from L2 to No L2.
- SOFT KEY 4 toggles the AP to Earth to No AP to Earth.

4. Press the print data key at any time to generate a printout of the latest measurement.

In Case of Failure

- Check any broken of the enclosure. Replace any defective part.
- Inspect wiring for bad crimps, poor connections, or damage.
- Test the wall outlet; verify it is grounded and is free of other wiring abnormalities. Notify the user or owner to correct any deviations. As a work around, check the other outlets to see if they could be used instead.
- Change another probe to confirm if the fail is caused by console.
- If the leakage current measurement tests fail on a new unit and if situation can not be corrected, submit a Safety Failure Report to document the system problem. Remove unit from operation.
- If all else fails, stop using and inform the Customer Service Engineer for analysis and disposal.

LIMITS

For IEC60601-1,

- 5mA in Normal Condition
- 10mA in Single Fault Condition

A.6 Patient Leakage Current

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

Preparation

Perform a calibration from the Mains on Applied Part menu.

The following outlet conditions apply when performing this test:

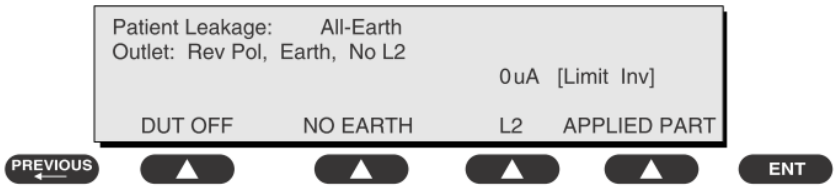
- Normal Polarity, Earth Open, Outlet ON Normal Polarity, Outlet ON
- Normal Polarity, L2 Open, Outlet ON Reversed Polarity, Outlet ON
- Reversed Polarity, Earth Open, Outlet ON Reversed Polarity, L2 Open, Outlet ON

⚠WARNING

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

To Perform the Test

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



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

In Case of Failure

- Check any broken of the enclosure. Replace any defective part.
- Inspect wiring for bad crimps, poor connections, or damage.
- Test the wall outlet; verify it is grounded and is free of other wiring abnormalities. Notify the user or owner to correct any deviations. As a work around, check the other outlets to see if they could be used instead.
- Change another probe to confirm if the fail is caused by console.
- If the leakage current measurement tests fail on a new unit and if situation can not be corrected, submit a Safety Failure Report to document the system problem. Remove unit from operation.
- If all else fails, stop using and inform the Customer Service Engineer for analysis and disposal.

LIMITS

For CF applied parts

- 10µA in Normal Condition
- 50µA in Single Fault Condition

For BF applied parts

- 100µA in Normal Condition
- 500µA in Single Fault Condition

A.7 Mains on Applied Part Leakage

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

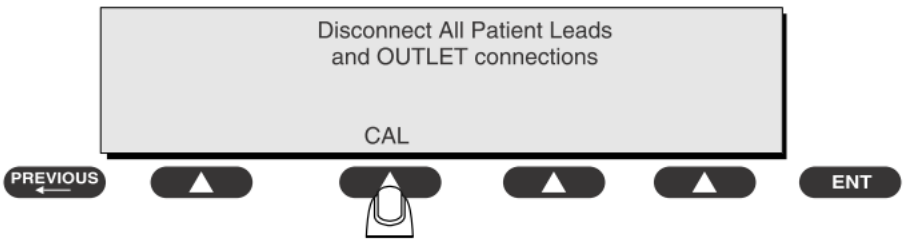
The following outlet conditions apply when performing the Mains on Applied Part test.

- Normal Polarity;
- Reversed Polarity

Preparation

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

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



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

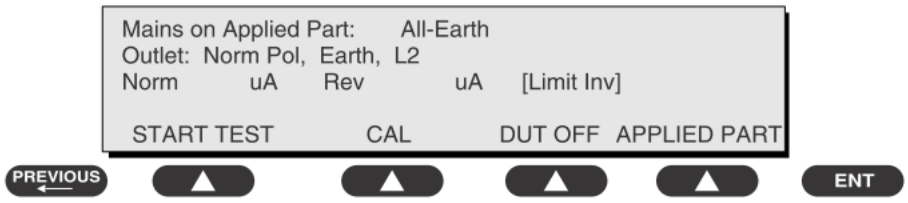
3. When the calibration is finished, the Mains on Applied Part test will reappear.

⚠WARNING

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

To Perform the Test

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



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

NOTE

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

In Case of Failure

- Check any broken of the enclosure. Replace any defective part.
- Inspect wiring for bad crimps, poor connections, or damage.
- Test the wall outlet; verify it is grounded and is free of other wiring abnormalities. Notify the user or owner to correct any deviations. As a work around, check the other outlets to see if they could be used instead.
- Change another probe to confirm if the fail is caused by console.
- If the leakage current measurement tests fail on a new unit and if situation can not be corrected, submit a Safety Failure Report to document the system problem. Remove unit from operation.
- If all else fails, stop using and inform the Customer Service Engineer for analysis and disposal.

LIMITS

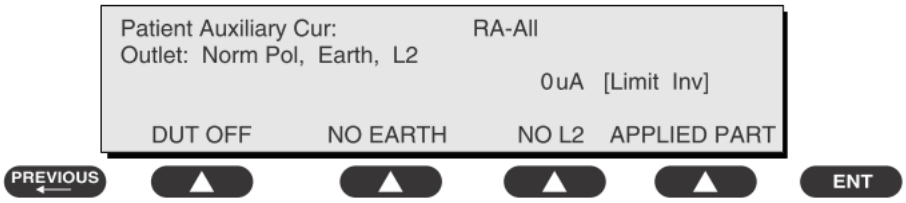
- For CF applied parts: 50 µA
- For BF applied parts: 5000 µA

A.8 Patient Auxiliary Current

Patient Auxiliary currents are measured between any selected ECG jack and the remaining selected ECG jacks. All measurements may have a true RMS only response.

Preparation

1. From the MAIN MENU, or with the outlet unpowered, plug the DUT into the 601PRO front panel outlet, and turn on the device.
2. Attach the patient leads to the 601PRO ECG jacks.
3. Define the Lead Types from the View Settings Option (refer to: Lead Type Definitions in Section 5 of this chapter).
4. Press shortcut key 8. The Patient Auxiliary Current test is displayed, and the test begins immediately. Display values are continuously updated until another test is selected.



5. Press SOFT KEYS 1-4 to select leakage tests
6. Press APPLIED PART (SOFT KEY 4) at any time to select the desired applied part leakage current:
7. Modify the configuration of the front panel outlet by pressing the appropriate SOFT KEY on the 601PRO:
8. Press the print data key at any time to generate a printout of the latest measurement.

In Case of Failure

- Check any broken of the enclosure. Replace any defective part.
- Inspect wiring for bad crimps, poor connections, or damage.

- Test the wall outlet; verify it is grounded and is free of other wiring abnormalities. Notify the user or owner to correct any deviations. As a work around, check the other outlets to see if they could be used instead.
- Change another probe to confirm if the fail is caused by console.
- If the leakage current measurement tests fail on a new unit and if situation can not be corrected, submit a Safety Failure Report to document the system problem. Remove unit from operation.
- If all else fails, stop using and inform the Customer Service Engineer for analysis and disposal.

LIMITS

For CF  applied parts,

- 10μA in Normal Condition
- 50μA in Single Fault Condition

For BF  applied parts,

- 100μA in Normal Condition
- 500μA in Single Fault Condition

ELECTRICAL SAFETY INSPECTION FORM

Overall assessment:

Scheduled inspection	Test item: 1, 2, 3, 4, 5, 6, 7, 8

Location:					**Technician:**	
Equipment:					**Control Number:**	
Manufacturer:		**Model:**			**SN:**	
Measurement equipment /SN:					**Date of Calibration:**	
INSPECTION AND TESTING					**Pass/Fail**	**Limit**
1	Power Cord Plug					
2	Device Enclosure and Accessories					
3	Device Labeling					
4	Protective Earth Resistance			Ω		Max 0.2 Ω
5	Earth Leakage	Normal condition(NC)		____μA		Max: NC: 5mA SFC: 10mA
		Single Fault condition(SFC)		____μA		
6	Patient Leakage Current	Normal condition(NC)		□BF____μA		Max: CF applied part: NC:10μA, SFC: 50μA BF applied part: NC:100μA, SFC: 500μA
				□CF____μA		
		Single Fault condition(SFC)		□BF____μA		
				□CF____μA		
7	Mains on Applied Part Leakage			□BF____μA		Max: CF applied part: 50μA BF applied part: 5000μA
				□CF____μA		
8	Patient Auxiliary Current	Normal condition(NC)		□BF____μA		Max: CF applied part: NC:10μA, SFC: 50μA BF applied part: NC:100μA, SFC: 500μA
				□CF____μA		
		Single Fault condition(SFC)		□BF____μA		
				□CF____μA		

Name/ Signature: _____ Date:_____

Unopened repair type	Test item: 1, 2, 3
Opened repair type, not replace the power part including transformer or patient circuit board	Test item: 1, 2, 3, 4
Opened repair type, replace the power part including transformer	Test item: 1, 2, 3, 4, 5
Opened repair type, replace patient circuit board	Test item: 1, 2, 3, 4, 6, 7, 8

Location:					**Technician:**	
Equipment:					**Control Number:**	
Manufacturer:			**Model:**		**SN:**	
Measurement equipment /SN:					**Date of Calibration:**	
INSPECTION AND TESTING					**Pass/Fail**	**Limit**
1	Power Cord Plug					
2	Device Enclosure and Accessories					
3	Device Labeling					
4	Protective Earth Resistance			Ω		Max 0.2 Ω
5	Earth Leakage	Normal condition(NC)		____μA		Max: NC: 5mA SFC: 10mA
		Single Fault condition(SFC)		____μA		
6	Patient Leakage Current	Normal condition(NC)		□BF____μA		Max: CF applied part: NC:10μA, SFC: 50μA BF applied part: NC:100μA, SFC: 500μA
				□CF____μA		
		Single Fault condition(SFC)		□BF____μA		
				□CF____μA		
7	Mains on Applied Part Leakage			□BF____μA		Max: CF applied part: 50μA BF applied part: 5000μA
				□CF____μA		
8	Patient Auxiliary Current	Normal condition(NC)		□BF____μA		Max: CF applied part: NC:10μA, SFC: 50μA BF applied part: NC:100μA, SFC: 500μA
				□CF____μA		
		Single Fault condition(SFC)		□BF____μA		
				□CF____μA		

Name/ Signature: _____ Date:_____

PN: 046-012997-00 (1.0)