BeneVision N17/BeneVision M17

BeneVision N15/BeneVision M15

BeneVision N12/BeneVision M12/

BeneVision N12C

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.

- Version number: 7.0
- Release time: 2022-04

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

FOR YOUR NOTES

1 Safety

1.1 Safety Information

⚠ DANGER

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

⚠ WARNING

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

⚠ 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 Dangers

There are no dangers that refer to the product in general. Specific "Danger" statements may be given in the respective sections of this manual.

1.1.2 Warnings

⚠WARNING

- **All installation operations, expansions, changes, modifications and repairs of this product are conducted by Mindray authorized personnel.**
- **There is high voltage inside the equipment. Never disassemble the equipment before it is disconnected from the AC power source.**
- **When you disassemble/reassemble a parameter module, a patient leakage current test must be performed before it is used again for monitoring.**

- **The equipment must be connected to a properly installed power outlet with protective earth contacts only. If the installation does not provide for a protective earth conductor, disconnect it from the power line and operate it on battery power, if possible.**
- **Dispose of the package material, observing the applicable waste control regulations and keeping it out of children's reach.**

1.1.3 Cautions

⚠CAUTION

- **Make sure that no electromagnetic radiation interferes with the performance of the equipment when preparing to carry out performance tests. Mobile phone, X-ray equipment or MRI devices are a possible source of interference as they may emit higher levels of electromagnetic radiation.**
- **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.**
- **Protect the equipment from damage caused by drop, impact, strong vibration or other mechanical force during servicing.**

1.1.4 Notes

NOTE

- **Refer to Operation Manual for detailed operation and other information.**

1.2 Equipment Symbols

See the N series Operator's Manual for information about the symbols used on this product and its packaging.

2 Operation Theory

2.1 Overview

As a bedside workstation for multi-parameter monitoring, the N series and M series can provide the complete patient management, abundant physiological parameter monitoring and physiological alarm functions, as well the powerful data review function and the flexible wired and wireless network configuration and application capabilities. The third-party application can be accessed easily through the iView application, meeting the increasingly common information requirements of hospitals. The provided series of CAA applications can help doctors to make auxiliary diagnosis for patients. Meanwhile, the N series and M series provide the hospital management personnel with more excellent monitor management applications, rendering assistance in fixing the efficiency and quality problems during monitor equipment management of hospitals.

The N series and M series provide the product models with display screens of different sizes according to the demand of clinical application. In addition to touch screen operations, the user can use the mouse and keyboard to operate the monitor. The N series and M series can connect to multiple display screens to function as mirror screens or extension screens.

The series of products are compatible with the BeneView T series plug-in modules and related accessory products. They can work together with the TDS to implement the intra-hospital transfer application of patients.

In comparison with the BeneView T series products, the N series and M series boast better human-computer interaction design and clinical applicability, more complete IT solution capability of hospitals, and more abundant CDS applications.

2.2 Product System Architecture

All the N17/N15/N12/M17/M15/M12 monitors have only one main unit:

- The N12/M12 main unit uses the 12.1" TFT WXGA display screen.
- The N15/M15 main unit uses the 15.6" TFT FHD display screen.
- The N17/M17 main unit uses the 18.5"TFT FHD display screen.
- All of them use the touch screen as an input device and can extend the mouse, keyboard and remote control.
- An internal module rack is integrated, with 4 slots (N12) or 6 slots (N15/N17).
- The MPAN and WiFi modules are optional.
- The built-in recorder is optional.
- The N15/M15/N17/M17 can connect to the external module rack and TDS; the N12/M2 can connect to the TDS.

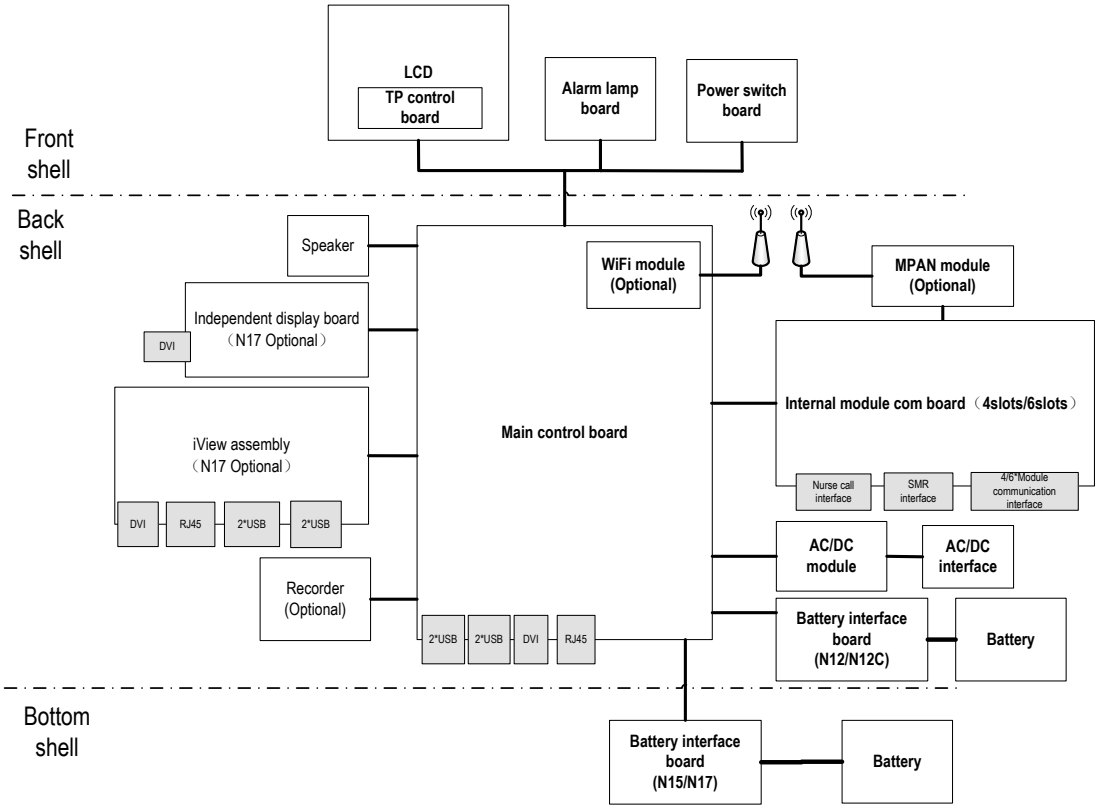


Figure 2-1 System block diagram of the N17/M17/N15/M115/N12/N12C/M12

2.2.1 Main Control Board

There are the main control CPU, program memory, data memory, system configuration memory, system FPGA, Wi-Fi module (optional), power management MCU, battery charging circuit, and DC-DC circuit on the main control board. The internal interface and external interfaces are also provided on the board. The internal interface is an interface between the recorder, internal module rack COM board, AC-DC, and the battery. The external interfaces refer to the DVI display interface, USB interface, and Ethernet interface.

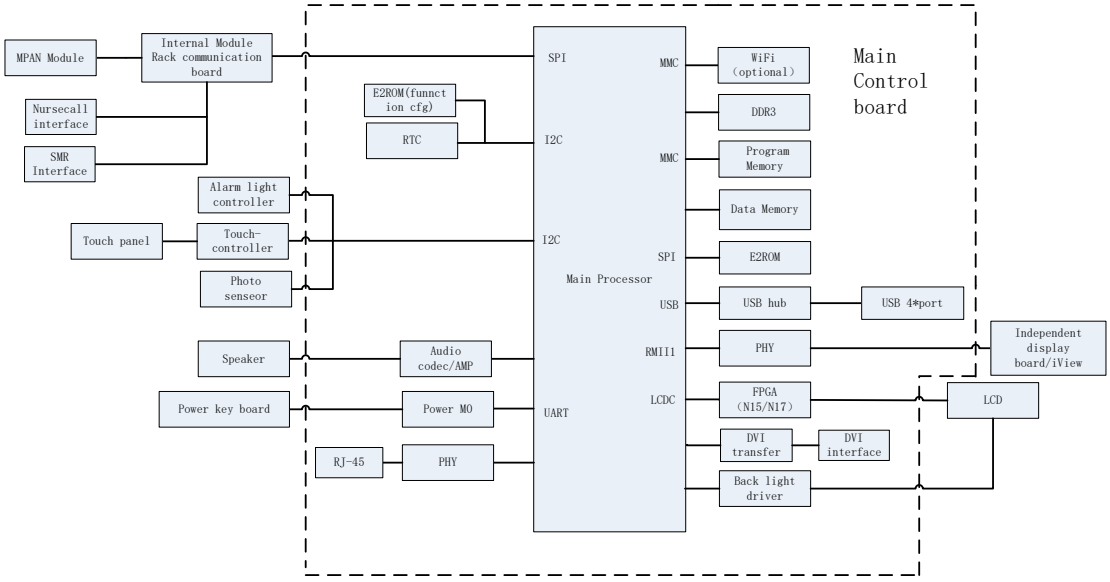


Figure 2-2 Diagram of the main control board

2.2.2 Internal Module Rack COM Board

Two models of internal module rack COM boards are available. The N12/M12 uses the 4-slot COM board, and the N15/M15/N17/M17 uses the 6-slot COM board. The internal module rack COM board is used to provide the interface for communication with the parameter module, the SMR interface and nurse call interface, and the MPAN module interface. Besides, the data forwarding FPGA and corresponding power circuit are also provided on the internal module rack COM board.

2.2.3 Power Architecture

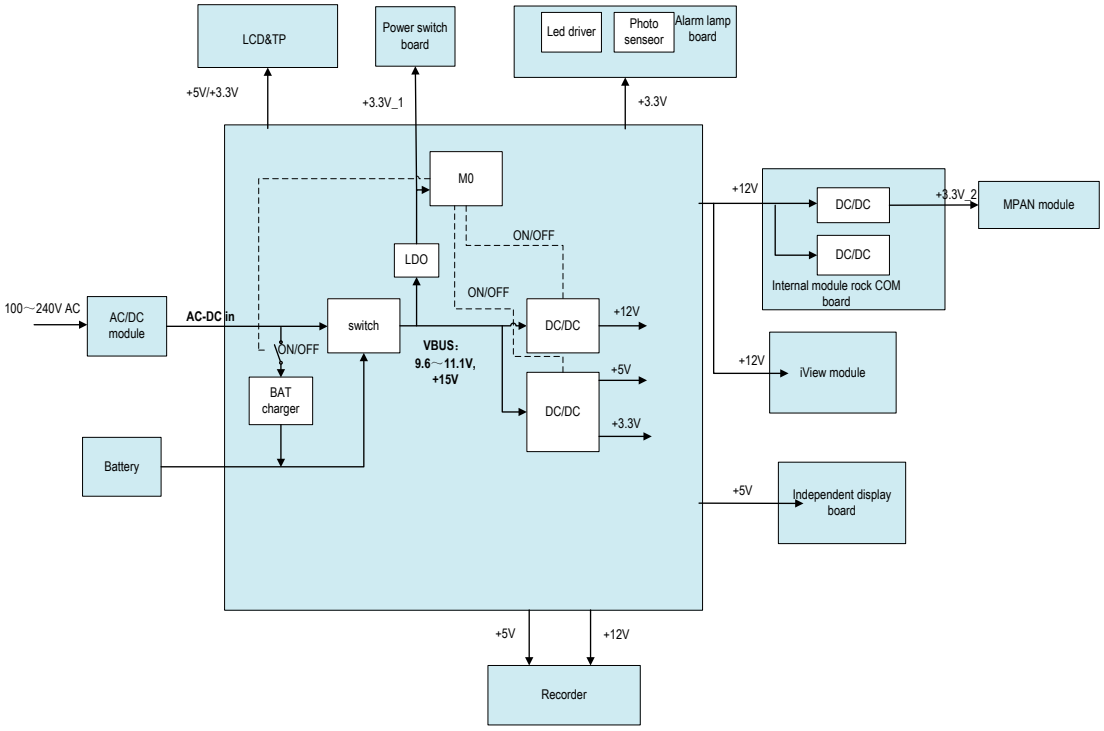


Figure 2-3 Diagram of power architecture

The AC/DC power module outputs 15V to the main control board, and 3.3V, 5V and 12V can be generated through the internal DC-DC conversion circuit in the main control board to provide a power supply to other modules or boards in the main unit. The battery charging circuit is powered by 15V, and the AC power supply and battery power supply can be switched according to AC on-line detection.

The +12V power supply is provided to the power supply, including the external module rack, and the DC-DC isolation design is implemented at the module end.

The iVIew assembly uses the power rail Vbus, which is the switching output between the AC-DC output and battery and aims to avoid abnormal power failure of the iView module and running exception of the Windows OS running on other modules due to an unexpected power failure of the AC power supply. The battery supports the main unit to stop the iView module in the normal power-off mode. In the case of battery power supply, the iView module cannot start.

2.2.4 Independent Display Board (for the N17/M17 Only)

It is used to connect the main unit to a display and extend the main screen display. It adopts the DVI interface. Moreover, the external display with a touch screen can be supported through the USB interface of the main unit. At present, the supported display with a touch screen is Elo 1919LM.

2.2.5 iView Module (for the N17/M17 Only)

As an embedded computer module, it provides the following external interfaces: the network interface, DVI interface, and the USB interface. It can connect to the keyboard, mouse, network cable, and display independently. The configuration of the iView module is mutually exclusive with that of the independent display module.

2.2.6 Alarm LAMP Board

The LED alarm lamp and light sensor are provided on the board. The light sensor implements the ambient light detection and is used to adjust brightness of the LCD background light.

2.2.7 Power Switch Board

There are the power switch and three indicators on the power switch board, which are the AC on-line indicator, battery indicator, and the power-on indicator.

2.3 Data Logic Flow

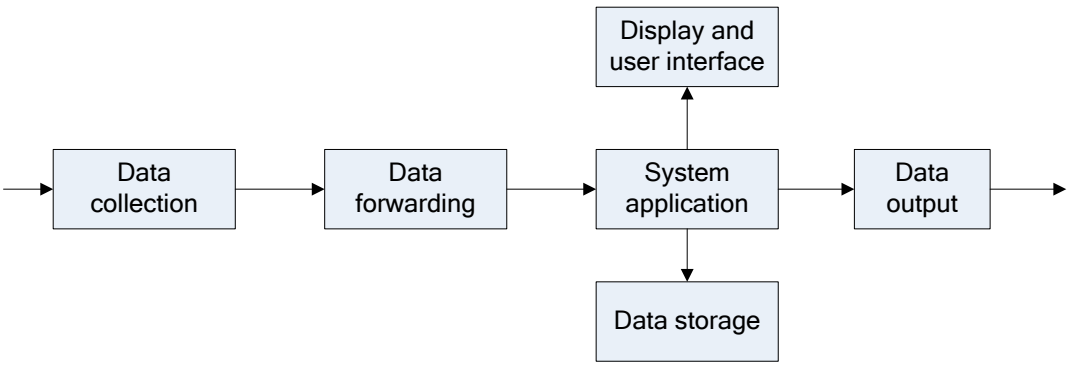


Figure 2-4 Data flow diagram

The monitoring parameters are collected and analyzed through the module, and then forwarded to the system software through the internal or external module rack. The system software displays the waveform, numerical value and alarm information, and the data, alarm information and numerical value are also stored in the internal data memory at the same time. Meanwhile, they can also be sent to the central station or other monitors through the wired or wireless network.

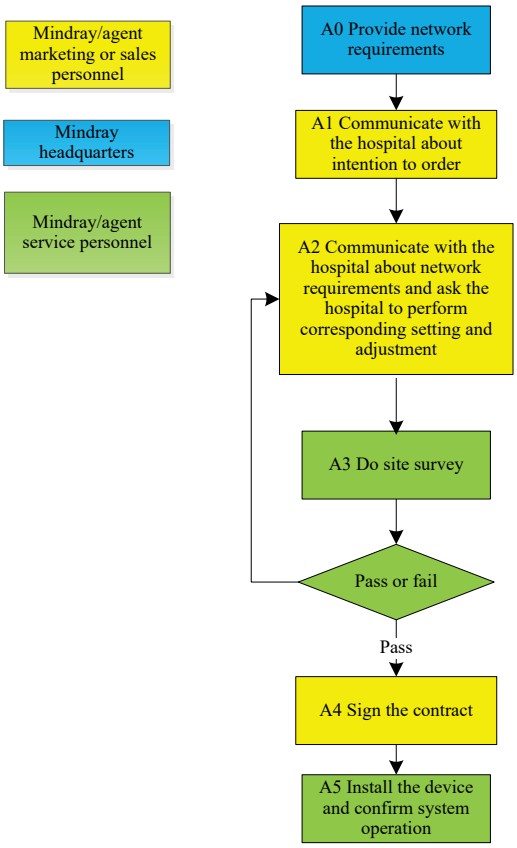
3 WLAN Installation

3.1 Introduction

This chapter describes how to install Mindray patient monitors using WLAN.

3.2 Network Deployment Process

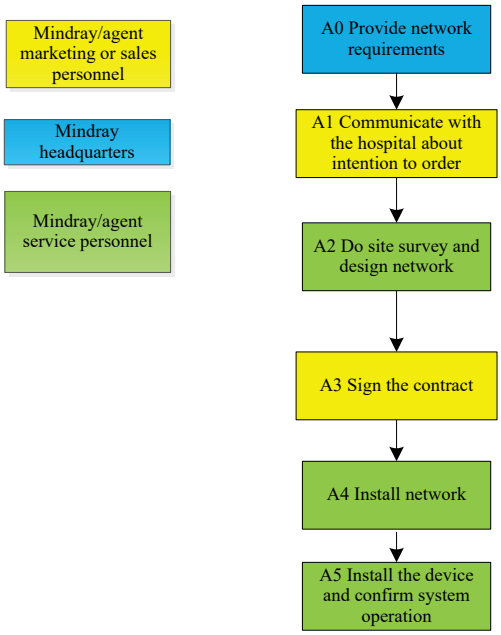
If the hospital has built its WLAN, the installation process is illustrated as follows:



3.2.1 List of outputs

Action	Output	Requirements	Template
A0	Wireless Network requirements for Mindray patient monitors	Determine requirements for deployment of the wireless network for Mindray patient monitors.	Wireless Network Requirement Table in ***3.3 Network Requirements***
A3	Network acceptance report	Confirm that the customer network meets requirements of Mindray patient monitors by means of questionnaire and measurement.	Wireless Network Acceptance Table in ***3.4.3 Network Verification Process***
A5	Installation confirmation report	Confirm the actual operation of the Mindray patient monitors after installation.	Patient Monitor Installation Confirmation Table in ***3.5 Network Coverage Assessment with Patient Monitors***

If the hospital plans to build a new WLAN for the Mindray patient monitors, make sure that there is at least one idle Wi-Fi channel that is not in use. Otherwise, you can't make co-channel interference meet Mindray patient monitors' requirement after the new WLAN is built. The installation process is illustrated as follows:



Action	Output	Requirements	Template
A0	Wireless Network requirements for Mindray patient monitors	Determine requirements for deployment of the wireless network for Mindray patient monitors.	Wireless Network Requirement Table in ***3.3 Network Requirements***
A2	Network design document, Bill of material	/	/
A5	Installation confirmation report	Confirm the actual operation of the Mindray patient monitors after installation.	Patient Monitor Installation Confirmation Table in ***3.5 Network Coverage Assessment with Patient Monitors***

NOTE

- **Network design and deployment project needs much more complex process, you need professional IT engneer's help to finish the job. This document does not include these contents.**

3.3 Network Requirements

The Wireless infrastructure needs to meet the following requirements.

Table 3-1 Wireless Network Requirement Table

No.	Item	Content of Requirements
Wireless coverage requirements		
1	Received signal strength (RSSI)	≥-65 dBm RSSI is the value displayed on the patient monitor
2	Co-channel interference	≤-20dB (co-channel interference AP's RSSI shall be at least 20 dB lower than the AP that patient monitor uses.)
3	Ping delay	The mean delay of PC or cell phone is smaller than 100ms and The packet lost rate shall be less than 1%.
Requirements of AP capability		
1	AP capability	1. The anticipated number of devices connecting to one AP must be lower than 50% of the AP capability. For example, In the coverage of one AP, the typical number of devices connected to this AP is 16, then the announced number of devices that can connect to AP simultaneously must be more than 32. 2. The AP Can create several SSIDs.
2	Device density	The maximum number of devices connected to one AP simultaneously is 16 (including patient monitors and other devices).
WLAN features		
1	AP channel width	Set the channel width to 20MHz, don't use HT40 or even HT80.
2	802.11 protocol	WLAN can't use protocols that Mindray patient monitor can't support, e.g 802.11ac
3	Security mode	WLAN can't use Security mode that Mindray patient monitor can't support. Using WPA2-Enterprise or WPA2-PSK is recommended. Use a long password and change it

No.	Item	Content of Requirements
		frequently. If the hospital network supports WPA2-Enterprise, using WPA2-Enterprise can achieve higher security.
4	Dedicated VLAN	The patient monitors need to work on a dedicated VLAN. Using VLAN can minimize Broadcast or multicast data which can affect patient monitors' stability.
Important settings		
1	DHCP	The DHCP server reserves a sufficient number of IP addresses to ensure that the patient monitors can obtain an IP address.
2	IGMP snooping	If patient monitors use multicast, enable IGMP snooping
3	Multicas	If patient monitors use multicast, the multicast function of network should be enabled.
4	Beacon & DTIM	AP DTIM = 1, Beacon = 100ms
5	Service port	Refer to ***Mindray Patient Monitoring Network Whitepaper***; patient monitors need some certain TCP/UDP ports to be opened

3.4 Network Verification

3.4.1 Tools and Resources

- Laptop computer, where Windows 7 or later version is installed and wireless network card is equipped. We recommended laptop configured with Intel Centrino Wireless-N adapter. If your laptop is configured with some other wireless adapter, please make sure the adapter has a high degree of accuracy.
- Wireless network survey tool, we suggest to use professional survey tool such as tamograph, Wirelessmon or other professional network survey tool.
- Professional network engineer.

NOTE

- **The personnel who implement the Wi-Fi network survey should be well trained about Wi-Fi. If professional network engineers are not available, please ask some third party for help.**

3.4.2 Wi-Fi Signal Calibration

Before a wireless network survey tool (running on laptop computer) is used to test network coverage, follow this procedure to calibrate the RSSI of wireless network survey tool with a patient monitor

1. Keep the patient monitor and wireless network survey tool close. The distance between them is not greater than 30cm and the distance from human body is above 50 cm.
2. Move the patient monitor and Wireless network survey tool at the same time (keep the previous distance).
3. When the patient monitor reads the following RSSI values: -50 dBm, -60 dBm, -70 dBm and -80 dBm, record the RSSI values read by Wireless network survey tool.
4. Calibrate the RSSI of Wireless network survey tool to patient monitor when do site survey (the RSSI of Patient monitor is the benchmark to wireless coverage).

3.4.3 Network Verification Process

This part is completed through two ways: First the hospital completes items requiring self-check of the hospital's IT Dept, as indicated in the Network Verification Table. Then customer service personnel or authorized party confirms items on site and finally completes the Network Acceptance Table. If any item is found incompliant during network Verification test, adjustment should be made before the patient monitors installation.

When in test, the Wi-Fi network SSID broadcast needs to be enabled to ensure that the Wi-Fi SSID can be scanned.

Table 3-2 Wireless Network Acceptance Table

No.	Item	Content of Requirements	Verification Method	Check Results
Wireless coverage requirements				
1	Received signal strength (RSSI)	≥-65 dBm RSSI is the value displayed on the patient monitor	Service person performs the test by using network survey tool. Make sure that all expected coverage areas such as ward, corridor, toilet, stairs, and elevator are tested.	
2	Co-channel interference	≤-20dB	Service person performs the test by using network survey tool. Make sure that all expected coverage areas such as ward, corridor, toilet, stairs, and elevator are tested.	
3	Ping delay	The mean delay of PC or cell phone with normal Wi-Fi module is smaller than 100ms and The packet lost rate shall be less than 1%.	Service person performs the test: 1. Connect PC or cell phone with normal Wi-Fi module to AP. 2. Connect another PC to the LAN port where the central monitoring system is connected to. 3. Run the command""ping –t –l 32 –w 1000 IPaddress-of -cellphone" for 10 minutes. 4. Run" ctrl+c".	
Requirements of AP capability				

No.	Item	Content of Requirements	Verification Method	Check Results
1	AP capability	The anticipated number of devices connecting to one AP must be lower than 50% of the AP capability. For example, In the coverage of one AP, the typical number of devices connected to this AP is 16, then the announced number of devices that can connect to AP simultaneously must be more than 32. The AP can create several SSIDs.	Service personnel get the AP model from related hospital people or observe directly. According to the model, get the data sheet of AP to make sure the capability.	
2	Device density	The maximum number of devices connected to one AP simultaneously is 12 (including patient monitors and other devices).	Check with hospital IT if this requirement is met or not.	
WLAN features				
1	AP channel width	Set the channel width to 20MHz, don't use HT40 or even HT80.	Check with hospital IT if this requirement is met or not.	
2	802.11 protocol	WLAN can't use protocols that Mindray patient monitor can't support, e.g 802.11ac	Check with hospital IT if this requirement is met or not.	
3	Security mode	WLAN can't use Security mode that Mindray patient monitor can't support. Using WPA2-Enterprise or WPA2-PSK is recommended. Use a long password and change it frequently. If the hospital network supports WPA2-Enterprise, using WPA2-Enterprise can achieve higher security.	Check with hospital IT if this requirement is met or not.	
4	Dedicated VLAN	The patient monitors need to work on a dedicated VLAN. Using VLAN can minimize Broadcast or multicast data which can affect patient monitors' stability.	Check with hospital IT if this requirement is met or not.	
Important settings				
1	DHCP	The DHCP server reserves a sufficient number of IP addresses to ensure that the patient monitors can obtain an IP address.	Check with hospital IT if this requirement is met or not.	

No.	Item	Content of Requirements	Verification Method	Check Results
2	IGMP snooping	If patient monitors use multicast, enable IGMP snooping	Check with hospital IT if this requirement is met or not.	
3	Multicast	If patient monitors use multicast. The multicast function of network should be enabled.	Check with hospital IT if this requirement is met or not.	
4	Beacon & DTIM	AP DTIM = 1, Beacon = 100ms	Check with hospital IT if this requirement is met or not.	
5	Service port	Refer to *Mindray Patient Monitoring Network Whitepaper*; patient monitors need some certain TCP/UDP ports to be opened	Check with hospital IT if this requirement is met or not.	

3.5 Network Coverage Assessment with Patient Monitors

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

Check whether coverage meets requirements by observing the signal strength (RSSI) showing on Patient monitor, and by observing whether an offline event occurs.

When necessary, adjust locations of APs or add APs to ensure the overage effect.Do as follows:

1. Set the patient monitor to access to CMS.
2. Ping the patient monitor on the CMS (input "ping –t –l 32 –w 1500 IP address" in window CLI (Ping the patient monitor persistently. The packet is 32 bytes and the timeout of reply is 1500ms). After ten minutes, input "ctrl + c" (finish the ping), make sure that the mean delay is less than 250ms and the packet lost rate shall be less than 1%.
3. Hold the patient monitor with a hand and avoid blocking by people. Walk in the expected coverage areas, for example, all corners of the ward, toilet, smoking area, corridor, and elevator.
4. Offline event time should be less than 10% of patient monitor roaming times; the RSSI value displayed on the patient monitor is not lower than -65dBm.
5. If the signal strength is lower than -65dBm during walking, stop at the location and observe for 30s. If the RSSI value is not lower than -65 dB in more than 66 percent of the time, the coverage requirement is met.

Table 3-3 Patient Monitor Installation Confirmation Table

Test or Observation Item	Result (Pass, Fail or NA)
Ping the patient monitor from the CMS and make sure that the mean delay is less than 250 ms and the packet lost rate shall be less than 1%.	
Hold the patient monitor and walk in the scope of different APs. After walking through the whole expected coverage area, observe continuous waveform on the CMS. Offline event times should be less than 10% of patient monitor roaming times.	
In the location where coverage is the poorest, signal strength displayed on the screen is higher than -65dBm.	

NOTE

- **If patient monitors do not need to roam between Aps, you can just place patient monitor where RSSI is lowest, and check the RSSI and ping results.**

3.6 Recommended Devices for WLAN

The following Cisco devices listed in table below are recommended.

Device	Part Number
2500 Wireless Controller	AIR-CT2504-x-K9
2600 Access Point	AIR-CAP2602I-x-K9

3.7 Setting Wireless Parameters for Patient Monitors

Follow the table below to configure the WLAN parameters of a patient monitor:

Parameter	Recommended Setting	Comments
Main Menu→Maintenance→User Maintenance→Network Setup→WLAN		
SSID	Set according to the WLAN deployment	/
Security Mode	WPA2-PSK	Should be the same as that of the WLAN deployed for patient monitor. If EAP used, choose the security mode according to the WLAN deployment.
Password	Set the password according to the WLAN deployment	/
Main Menu→Maintenance→User Maintenance→Network Setup→WLAN→WLAN Setup		
WLAN Band	5G	Options are: 2.4G, 5G and Auto. 2.4G = only use 2.4GHz band 5G = only use 5GHz band Auto = use both 2.4GHz and 5GHz bands(5GHz takes priority)
AUT. Server Type	ACS	Options are: ACS and SBR. ACS means Cisco Access Control Server. SBR means another server different from ACS. This only applies if the security type is Enterprise.
BG Channel	Specified	Options are: All, Specified, None. Specifying the channels improves stability and roaming performance by restricting the channels scanned to only those specified. For example, on a 2.4GHz network set channels 1, 6, and 11. BG channel settings on the monitor must match the WLAN AP channel settings.

Parameter	Recommended Setting	Comments
A Channel	Specified	Options are: All, Specified, None. Specifying the channels improves stability and roaming performance by restricting the channels scanned to only those specified. The 5GHz channel settings on the monitor must match the WLAN AP channel settings.
Main Menu→Maintenance→User Maintenance→Network Setup→WLAN→Certificate Management		
Local	/	Display the existing EAP certificates in a patient monitor
USB Drive	/	Display the existing EAP certificate in the USB drive
Main Menu→Maintenance→Factory Maintenance→Setup→WLAN Setup		
Regulatory Domain	Worldwide	Korea, Turkey, Russia, and Brazil need to be configured separately. For other countries, just choose worldwide. You need to restart the monitor for the monitor settings to take effect.
CCX Features	Support	This means that it supports CCX 4.0 and fast roaming
PMK Caching	Standard	Options are: Standard, OPMK. Standard indicates PMK caching. OPMK indicates opportunistic key caching.
Trigger	-70	When the RSSI is lower than the roam trigger, the radio will try to roam.
Scan Period	5	When the RSSI is lower than the roam trigger, the period of the probe request is 5s.

Patient monitor support the following security modes:

Menu Selection	Basic Algorithm	Authentication Mode	Encryption	CCKM Support
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 Security Mode of EAP is selected, corresponding configuration item will be displayed. The following table lists the configuration items for different EAP methods.

	Identity	Anonymity	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

Note: Y means yes, N means No, O means optional.

The meaning of each configuration item is shown below:

- AUT. Protocol (Phase2 Auth): When PEAP in the EAP Method is selected, the user can configure the following PEAP inner methods: EAP-MSCHAPV2, EAP-GTC, EAP-TLS.
- Identity: user identity, it is the user name in the AD, LDAP or local user management on the RADIUS server.
- Anonymity: This item does not impact the authentication process. The function of this item is to hide the real name (Identity).
- Password: the password for the Identity.
- CA Certificate: choose the CA Certificate from the imported certificates.
- User Certificate: choose the User Certificate from the imported certificates.
- PAC Certificate: When the EAP-FAST is selected, choose the PAC certificate from the imported certificates. If the RADIUS server has support In-band PAC provisioning to provision the client with a PAC, then there is no need to setup the PAC Certificate and password.
- PAC password: When the EAP-FAST is selected, input the PAC password for the PAC Certificate. If the RADIUS server has support In-band PAC provisioning to provision the client with a PAC, then there is no need to setup the PAC Certificate and password.

3.8 Troubleshooting

Symptom	Possible Cause	Recommended Measure
The monitor cannot connect to the AP and an X is displayed on the Wi-Fi signal icon on the monitor.	The nearby AP is not turned on.	Ensure that the AP is turned on and belong to the VLAN where the monitor resides.
	The monitor is not turned on in the coverage area of the AP.	Walk to the coverage area of the AP and turn on the monitor. Ensure that the signal strength indicated on the monitor is larger than –65 dBm. Ensure that the intra-frequency interference meets the requirement.
	The SSID, IP address acquisition mode, and security mode are not correctly configured on the monitor.	Configure the information again by referring to this manual.
	The monitor fails.	Check whether another monitor can get online. If yes, restart the monitor and ensure that the configurations of the two monitors are consistent. If the monitor still cannot get online, return the monitor to Mindray for repair.
The monitor can connect to the AP but cannot connect to the CMS.	The monitor is not admitted on the CMS.	Admit the monitor on the CMS.
	The monitor cannot obtain any IP address and the IP addresses in the IP address pool on the DHCP server are used up.	Enable other network equipment to connect to the CMS and check whether an IP address can be obtained. If the problem cannot be solved, contact the IT department.

Symptom	Possible Cause	Recommended Measure
	A static IP address conflict occurs.	Observe whether a prompt indicating IP address conflict is displayed on the monitor. If so, make sure all network devices have unique IP addresses.
	The network link fails.	Check whether the CMS can be pinged by using PC or cell-phone. If the problem cannot be solved, contact the IT department.
	The services required by the monitor are not enabled on the hospital network.	Check whether the services required by the monitor are enabled on the hospital network and enable related services, such as certain UDP ports and multicast. If the problem cannot be solved, contact the IT department.
A single monitor becomes disconnected intermittently	The monitor moves to a coverage hole.	Ensure that the signal strength is larger than –65 dBm at the position where the monitor is disconnected.
	The monitor is faulty.	Check whether the monitor is disconnected easily at the same position. If the problem cannot be solved after the monitor is restarted, return the monitor to Mindray for repair.
	A static IP address conflict occurs.	Observe whether a prompt indicating IP address conflict is displayed on the monitor. Check whether an IP address is assigned to more than one device.
Multiple monitors become disconnected intermittently	The APs in some areas are damaged.	Ensure that the APs are turned on and run properly.
	The interference is intense in certain areas.	Check whether the interference is intense by using a network survey tool and remove obvious interference sources or adjust WLAN deployment to meet the requirements of Mindray.
	The signal coverage is insufficient in some areas.	Check the signal coverage by using network survey tool. If signal coverage is insufficient in any area, adjust the position of the AP or add an AP.
All monitors become disconnected intermittently	The wired network is configured improperly.	Check the wired network configuration by using a wired monitor. Ensure that the WLAN bandwidth configured on the switch is sufficient with a margin of 50%.
	There is radio interference.	Check whether there is radio interference by using network survey tool and remove obvious interference sources or adjust WLAN deployment to meet the requirements of Mindray.

FOR YOUR NOTES

4 Testing and Maintenance

4.1 Introduction

To ensure the patient monitor always functions properly, qualified service personnel should perform regular inspection, maintenance and test. This chapter provides a checklist of the testing procedures for the patient monitor with recommended test equipment and frequency. The service personnel should perform the testing and maintenance procedures as required and use appropriate test equipment.

The testing procedures provided in this chapter are intended to verify that the patient monitor meets the performance specifications. If the patient monitor or a module fails to perform as specified in any test, repairs or replacement must be done to correct the problem. If the problem persists, contact our Customer Service Department.

⚠CAUTION

- **All tests should be performed by qualified service personnel only.**
- **Care should be taken when changing the settings in Maintenance and Configuration menus to avoid loss of data.**
- **Service personnel should possess a working knowledge of the test tools and make sure that test equipment and cables are applicable.**

4.1.1 Test Equipment

See the following sections.

4.1.2 Test Report

Upon completion of the tests, the table of preventative maintenance test reports and the table of maintenance test reports in this chapter should be kept properly.

4.1.3 Preventative Maintenance

The following sections provide a list of recommended preventative maintenance procedures. It is recommended to maintain the patient monitor at least once every two years (and once a year for CO_2 and AG modules). (See the following sections for detailed test procedures and contents)

4.1.4 Recommended Frequency

<table>
<tr><th colspan="2">Check/Maintenance Item</th><th>Frequency</th></tr>
<tr><td colspan="3">Preventative Maintenance Tests</td></tr>
<tr><td colspan="2">Visual inspection</td><td>When first installed or reinstalled.</td></tr>
<tr><td rowspan="2">NIBP tests</td><td>Pressure check</td><td rowspan="5">1. If the user suspects that the measurement is incorrect.
2. Following any repair or replacement of relevant module.
3. For NIBP module, at least once every two years; for CO_2 and AG modules, once a year.
4. AG leakage test should be performed before AG measurement.</td></tr>
<tr><td>Leakage test</td></tr>
<tr><td rowspan="3">Sidestream and Microstream CO_2 tests</td><td>Leakage test</td></tr>
<tr><td>Performance test</td></tr>
<tr><td>Calibration</td></tr>
</table>

<table>
<tr><td colspan="2">AG tests</td><td>Performance test</td><td rowspan="2"></td></tr>
<tr><td colspan="2"></td><td>Calibration</td></tr>
<tr><td colspan="4">Performance Tests</td></tr>
<tr><td colspan="2" rowspan="2">ECG tests</td><td>Performance test</td><td rowspan="20">1. If the user suspects that the measurement is incorrect.
2. Following any repair or replacement of relevant module.
3. At least once every two years. For CO_2, AG and NMT modules, at least once a year.
4. AG leakage test should be performed before AG measurement.</td></tr>
<tr><td colspan="2"></td><td>Calibration</td></tr>
<tr><td colspan="3">Resp performance test</td></tr>
<tr><td colspan="3">SpO_2 test</td></tr>
<tr><td colspan="2" rowspan="2">NIBP test</td><td>Pressure check</td></tr>
<tr><td colspan="2"></td><td>Leakage test</td></tr>
<tr><td colspan="3">Temp test</td></tr>
<tr><td colspan="2" rowspan="2">IBP tests</td><td>Performance test</td></tr>
<tr><td colspan="2"></td><td>Pressure calibration</td></tr>
<tr><td colspan="3">C.O. test</td></tr>
<tr><td colspan="3">Mainstream CO_2 test</td></tr>
<tr><td colspan="2" rowspan="3">Sidestream and Microstream CO_2 tests</td><td>Leakage test</td></tr>
<tr><td colspan="2"></td><td>Performance test</td></tr>
<tr><td colspan="2"></td><td>Calibration</td></tr>
<tr><td colspan="2" rowspan="3">AG tests</td><td>Leakage test</td></tr>
<tr><td colspan="2"></td><td>Performance test</td></tr>
<tr><td colspan="2"></td><td>Calibration</td></tr>
<tr><td colspan="3">EEG test</td></tr>
<tr><td colspan="3">BIS test</td></tr>
<tr><td colspan="3">RM test</td></tr>
<tr><td colspan="2" rowspan="2">CCO/SvO_2 tests</td><td>Interconnecting function</td></tr>
<tr><td colspan="2"></td><td>Output calibration</td></tr>
<tr><td colspan="2" rowspan="2">NMT tests</td><td>Performance test</td></tr>
<tr><td colspan="2"></td><td>Sensor check</td></tr>
<tr><td colspan="3">PiCCO test</td></tr>
<tr><td colspan="3">Nurse call relay performance test</td><td rowspan="2">If the user suspects that the nurse call or analog output does not work well.</td></tr>
<tr><td colspan="3">Analog output performance test</td></tr>
<tr><td colspan="3">EEG (self-made) test</td><td rowspan="2">Once every two years.</td></tr>
<tr><td colspan="3">ANI test</td></tr>
<tr><td colspan="4">Electrical Safety Tests</td></tr>
<tr><td rowspan="4">Electrical safety tests</td><td colspan="2">Earth impedance</td><td rowspan="4">1. Following any repair or replacement of the power module.
2. When the patient monitor is dropped.
3. At least every two years or as required.</td></tr>
<tr><td colspan="2">Earth leakage test</td></tr>
<tr><td colspan="2">Patient leakage current</td></tr>
<tr><td colspan="2">Patient auxiliary current</td></tr>
<tr><td colspan="4">Other Tests</td></tr>
<tr><td colspan="3">Power on test</td><td>1. When first installed or reinstalled.
2. Following any maintenance or the replacement of any main unit parts.</td></tr>
<tr><td colspan="3">Recorder check</td><td>Following any repair or replacement of the recorder.</td></tr>
<tr><td colspan="3">Network print test</td><td>1. When first installed.
2. Whenever the printer is serviced or replaced.</td></tr>
</table>

Device integration check		1. When first installed. 2. Following any repair or replacement of the external device.
Battery check	Function test	1. When first installed. 2. Whenever a battery is replaced.
	Performance test	Once a year or when the battery run time is reduced significantly.
Mounting check		1. When first installed. 2. At least every two years or as required.

Note: Performance test is not required for the ICG, rSO_2, Tympanic Temp and $ScvO_2$ modules, because the first three modules perform self tests, and the last one needs to be calibrated prior to use.

4.2 Preventative Maintenance Procedures

4.2.1 Visual Inspection

Inspect the equipment for obvious signs of damage. The test is passed if the equipment has no obvious signs of damage. Follow these guidelines when inspecting the equipment:

- Carefully inspect the case, display screen, buttons and handle for obvious signs of damage.
- Inspect the SMR and parameter modules for obvious signs of damage.
- Inspect the power cord, bracket and module accessories for obvious signs of damage.
- Inspect all external connections for loose connectors, bent pins or frayed cables.
- Inspect all connectors on the equipment for loose connectors or bent pins.
- Make sure that safety labels and data plates on the equipment are clearly legible.

4.2.2 NIBP Tests

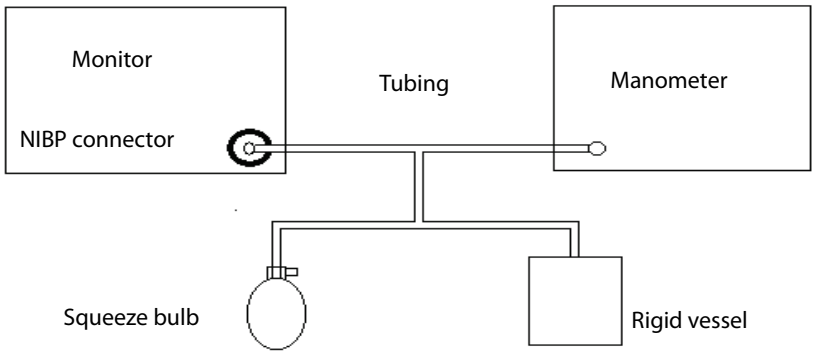
NIBP Accuracy Test

Tools required:

- T-shape connector
- Tubing
- Squeeze bulb
- Rigid vessel with volume 500±25 ml
- Reference manometer (calibrated with accuracy equal to or greater than 1 mmHg)

Follow this procedure to perform the test:

1. Connect the equipment as shown below.



2. Before inflation, the reading on the manometer should be zero. If not, open the valve of the squeeze bulb to let the whole airway open to the atmosphere. Close the valve after the reading turns to zero.
3. Select **Main Menu→Maintenance→**enter the required password**→Module→NIBP→NIBP Accuracy Test**.
4. Check the reading of the manometer and the reading of the patient monitor. Both should be 0 mmHg.
5. Raise the pressure in the rigid vessel to 50 mmHg with the squeeze bulb. Then, wait for 10 seconds until the measured values become stable.
6. Compare the reading of the manometer with the reading of the patient monitor. The difference should be 3 mmHg. If it is greater than 3 mmHg, contact your service personnel.
7. Raise the pressure in the rigid vessel to 200 mmHg with the squeeze bulb. Then, wait for 10 seconds until the measured values become stable. Repeat step 6.

NOTE

- **You can use an NIBP simulator to replace the squeeze bulb and the reference manometer to perform the test.**
- **You can use an appropriate cylinder and a cuff instead of the rigid vessel.**

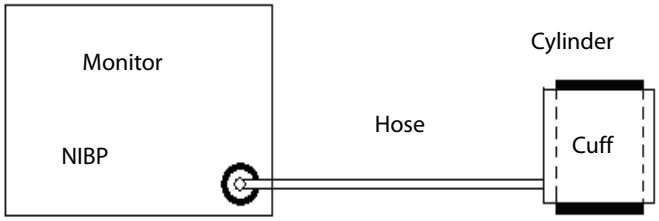
Leakage Test

Tools required:

- NIBP cuff for adult patient
- Tubing
- Cylinder

Follow this procedure to perform the test:

1. Set Patient Category to Adult.
2. Connect the NIBP cuff to the NIBP connector on the patient monitor.
3. Wrap the cuff around the rigid cylinder as shown below.



4. Select **Main Menu→Maintenance→**enter the required password**→Module→NIBP→NIBP Leakage Test**. The message NIBP Leakage Test is displayed in the NIBP parameter area.
5. The cuff automatically deflates after 20s, which means NIBP leakage test is completed.
6. If no message is displayed in the NIBP parameter area, it indicates that the system has no leak. If the message NIBP Pneumatic Leak is displayed, it indicates that the system may have a leak. In this case, verify the connections and make sure that the NIBP cuff, hose, and connectors are not leaking. Then, perform the test again.

You can also perform a manual leakage test:

1. Perform steps 1-4 in the ***NIBP Accuracy Test*** section.
2. Raise the pressure in the rigid vessel to 250 mmHg with the squeeze bulb. Then, wait for 5 seconds until the measured values become stable.
3. Record the current pressure value and meanwhile count time with a timer. Then, record the pressure value after counting to 60 seconds.
4. Compare the two values and make sure the difference is not greater than 6 mmHg.

NIBP Overpressure Protection Circuit Test

Tools required:

- T-shape connector
- Approprating tubing
- Balloon pump
- Metal Vessel with volume 500 ± 25 ml
- Reference manometer (calibrated with accuracy equal to or greater than 1 mmHg)

Follow this procedure to perform a NIBP calibration:

1. Perform procedures 1-4 in the NIBP Accuracy Test section.
2. Select **Main Menu→Maintenance→**enter the required password**→Factory Maintenance→NIBP**.
3. Set **Patient Category** to **Adult/Ped** in the **Overpressure Protection Circuit Test**. Raise the pump pressure to 320-330 mmHg. After the pressure value is stabilized, select the **Test** button to start a calibration, and the **NIBP** menu will display **Test successful**, When raise the pump pressure out of the range of 320-330 mmHg, and select the **Test** button to, the **NIBP** menu will display **Test Failed**.
4. Set **Patient Category** to **Neo** in the **Overpressure Protection Circuit Test**, and raise the pressure to 160-165 mmHg. After the pressure value is stabilized, select **Test** to start a calibration. and the **NIBP** menu will display **Test successful**, When raise the pump pressure out of the range of 160-165 mmHg, and select the **Test** button, the **NIBP** menu will display **Test Failed**.

4.2.3 Sidestream and Microstream CO_2 Tests

Leakage Test

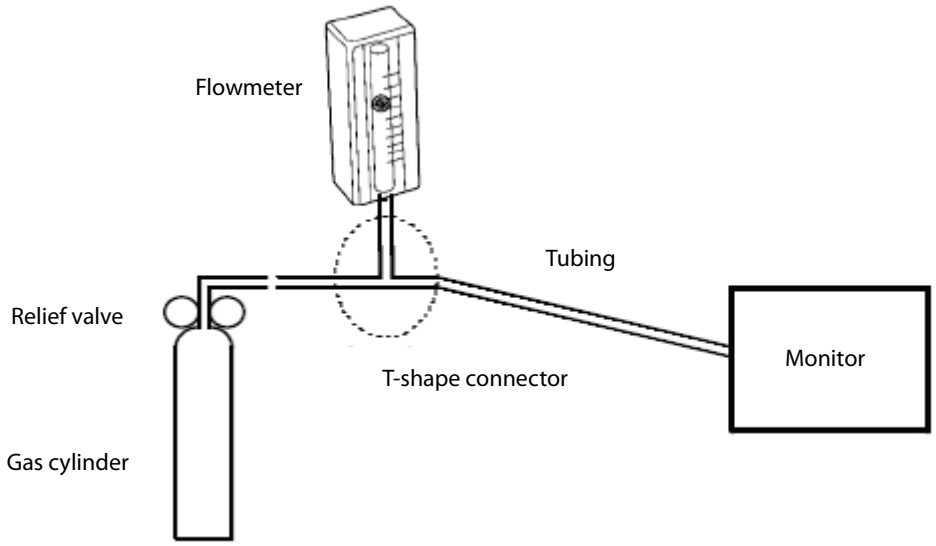
1. Plug the module into the module rack.
2. Wait until CO_2 warmup is finished and then completely block the gas inlet of the module or water trap (by using your finger or other objects). The sidestream and microstream CO_2 modules will behave as follows:
   - Sidestream: Plug the sidestream CO_2 module into the module rack of the main unit. Wait one minute until the module warmup is finished and then completely block the gas inlet of the module (you may use a pneumatic plug or your finger to manually occlude the port). An alarm message **CO2 Airway Occluded** will appear on the screen. Block the gas inlet for another 60 seconds. Select **Main Menu→Maintenance→**enter the required password**→Module→CO2→Calibration**. If the flow rate is less than 10 ml/min and the alarm message continues, it indicates that the module does not leak. If the alarm message **CO2 Airway Occluded** disappears, or the flow rate is greater than or equal to 10 ml/min, it indicates that the module leaks.
   - Microstream: The alarm message **CO2 Purging** is displayed on the screen after 3 seconds. Block the gas inlet for another 30 seconds. If alarm message **CO2 Airway Occluded** is displayed, it indicates that the module does not leak.

Accuracy Test

Tools required:

- A steel gas cylinder with CO_2 (concentration range: 3%~7%) and balance gas N_2
- A steel gas cylinder with >40% O_2 and balance gas N_2 (applicable to sidestream CO_2 module with O_2 module equipped)
- T-shape connector
- Tubing
- Flowmeter

1. Plug the module into the module rack.
2. Wait until the CO_2 module warmup is finished. Check the airway for leak and perform a leakage test as well to make sure that the airway has no leak.
3. Select **Main Menu→Maintenance→**enter the required password**→Module→CO2→Calibration**.
4. Connect the test system as follows:



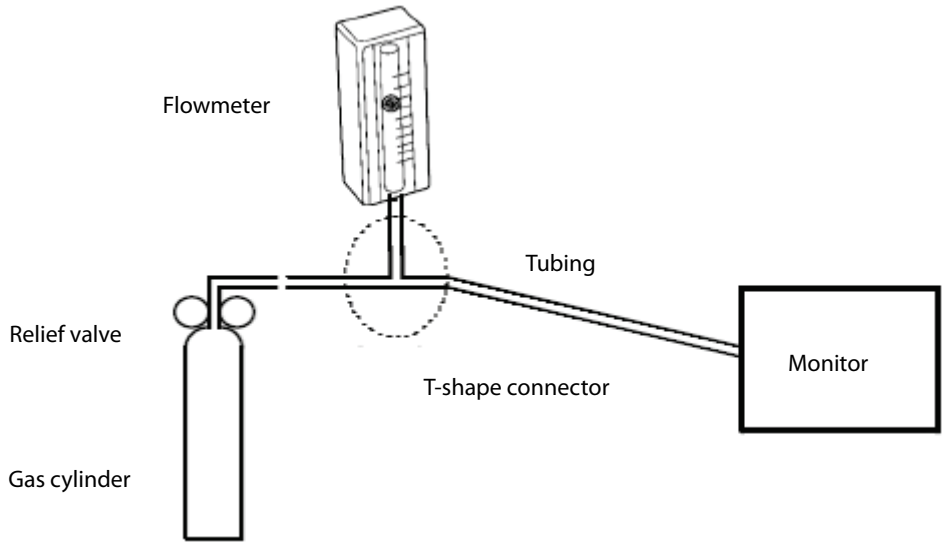
5. Open the relief valve, and adjust it until the flowmeter has a stable reading between 10 ml/min and 50 ml/min.
6. Check the real-time CO_2 value in the Calibrate CO2 menu and make sure the variation from the actual concentration is within ±2% (for microstream CO_2, the value is 45±2 mmHg).
7. Replace the cylinder to the steel gas cylinder with >40% O_2 and balance gas N2(applicable to sidestream CO_2 module with O_2 module equipped) and verify that the real-time O_2 value error is within ±2% (when O_2≤80%) or ±3% (80%≤O_2≤100%).

Calibration

Tools required:

- A steel gas cylinder with CO_2 (concentration range: 3%~7%) and balance gas N_2
- A steel gas cylinder with >40% O_2 and balance gas N_2 (applicable to sidestream CO_2 module with O_2 module equipped)
- T-shape connector
- Tubing
- Flowmeter

1. Make sure that the sidestream or microstream CO_2 module has been warmed up or started up.
2. Check the airway for leaks and perform a leakage test as well to make sure that the airway has no leakage.
3. Select **Main Menu**→**Maintenance**→enter the required password→**Module**→**CO2**.
4. In the **CO2** menu, select **Zero**.
5. After the zero calibration is finished successfully, connect the equipment as follows:



6. Open the relief valve, and adjust it until the flowmeter has a stable reading between 10 ml/min and 50 ml/min.
7. In the **Calibrate CO2** menu, enter the CO_2 concentration in the CO2 field.
8. In the **Calibrate CO2** menu, the measured CO_2 concentration is displayed. After the measured CO_2 concentration becomes stable, select **Calibrate CO2** to calibrate the CO_2 module.
9. Replace the cylinder to the steel gas cylinder with >40% O2 and balance gas N2(applicable to sidestream CO2 module with O2 module equipped) and calibrate O2.

If the calibration is finished successfully, the message **Calibration Completed!** is displayed in the **Calibrate CO2** menu. If the calibration failed, the message **Calibration Failed!** is displayed. In this case, check whether the operations are correct and perform another calibration. If the calibration fails several times, return the module to Mindray for repair.

4.2.4 AG Tests

Leakage Test

1. Plug the AG module into the module rack.
2. Wait until the AG module warmup is finished and then completely block the gas inlet of the AG module (you may use a pneumatic plug or your finger to manually occlude the port). An alarm message AG Airway Occluded will appear on the screen.
3. Block the gas inlet for another 60 seconds. Select **Main Menu→Maintenance→**enter the required password**→ Module→AG→Calibration**. Check that the flow rate is less than 10 ml/min. If the alarm message continues, it indicates that the module does not leak.

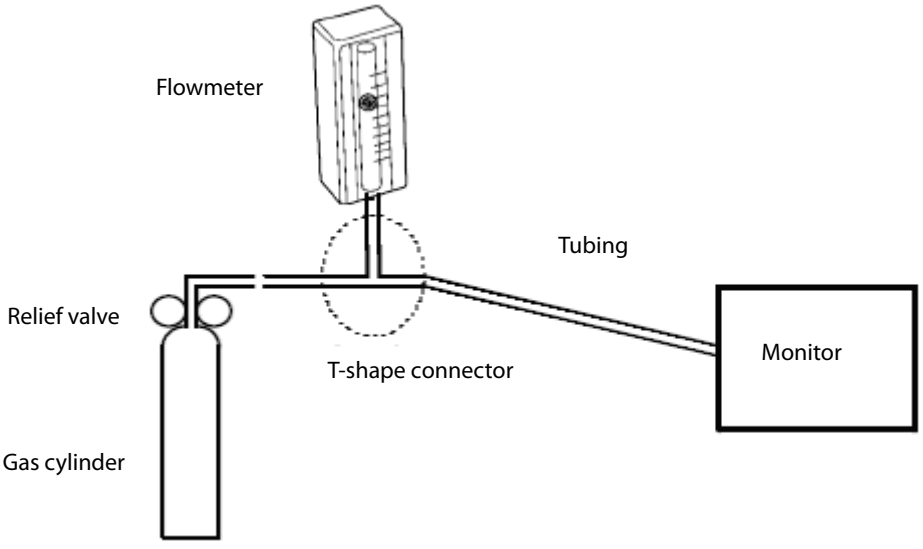
If the alarm message disappears, or the flow rate is greater than or equal to 10 ml/min, it indicates that the module leaks.

Accuracy Test

Tools required:

- Gas cylinder with a certain standard gas (such as 6±0.05% CO_2, Bal N_2) or standard gas mixture. Gas concentration should meet the following requirements: AA [1.5%,7.0%], set step length: 0.1, CO_2 [1.5%,7.0%], set step length: 0.1, N_2O [40%,100%], set step length: 5, O_2 [40%,100%], set step length: 5, of which AA represents an anesthetic agent. Precision requirement: $a/c \leq 0.01$ (a is the gas absolute concentration accuracy; c is the gas concentration)
- T-shape connector
- Tubing
- Flowmeter

1. Plug the AG module into the module rack.
2. Wait at least 10 min and then perform a leakage test to make sure that the airway has no leakage.
3. Connect the test system as follows:



4. Open the relief valve, and adjust it until the flowmeter has a stable reading between 10 ml/min and 50 ml/min.
5. Verify that the concentration of each composition meets the specification stated in the Operator's Manual.

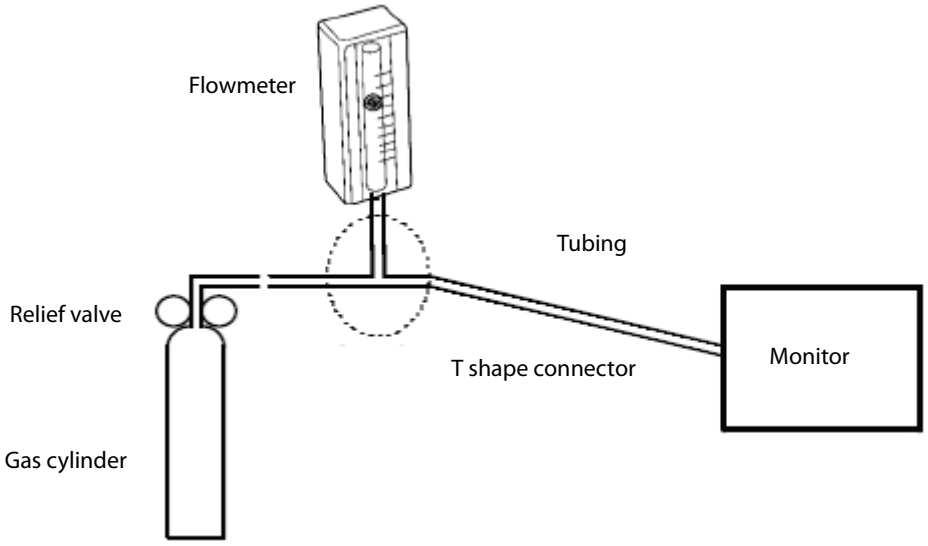
Calibration

Tools required:

- Gas cylinder with a certain standard gas (such as 6±0.05% CO2, Bal N2) or standard gas mixture. Gas concentration should meet the following requirements: AA [1.5%,7.0%], set step length: 0.1, CO2 [1.5%,7.0%], set step length: 0.1, N2O [40%,100%], set step length: 5, O2 [40%,100%], set step length: 5, of which AA represents an anesthetic agent. Precision requirement: a/c ≤ 0.01 (a is the gas absolute concentration accuracy; c is the gas concentration)
- T-shape connector
- Tubing
- Flowmeter

Follow this procedure to perform a calibration:

1. Select **Main Menu**→**Maintenance**→enter the required password→**Module**→**AG**.
2. Check the airway and make sure that there are no occlusions or leaks.
   - Vent the sampling tubing to the air and check if the Current Flow Rate and Set Flow Rate are approximately the same. If the deviation is great, it indicates that there is an occlusion in the tubing. Check the tubing for an occlusion.
   - Perform a leakage test to make sure that the airway has no leakage.
3. Connect the test system as follows:
4. Open the relief valve and vent a certain standard gas or gas mixture. Adjust the relief valve until the flowmeter has a stable reading between 10 ml/min and 50 ml/min.



5. In the **Calibrate AG** menu, the concentration and flowrate of each measured gas are displayed.
   - If the difference between the measured gas concentration and the actual one is within tolerance, a calibration is not needed.
   - If the difference is not within tolerance, a calibration should be performed. Select **Calibrate**.
6. Enter the vented gas concentration. If you use only one gas for calibration, set other gases' concentration to 0. If the calibration is performed for all gases, the gas with an entered calibration value of 0 is not calibrated.
7. Select **Calibrate** to start a calibration.

8. If the calibration is finished successfully, the message **Calibration Completed!** is displayed. If the calibration failed, the message **Calibration Failed!** is displayed. In this case, perform another calibration. If the calibration fails several times, return the module to Mindray for repair.

⚠CAUTION

- **Calibrate the O_2 module, if it has been transported for long distance.**

4.3 Power On Test

This test is to verify that the patient monitor can power up correctly. The test is passed if the patient monitor starts up by following this procedure:

1. Connect the patient monitor to the AC mains. The AC mains LED and battery LED light up.
2. Press the power on/off switch to switch on the patient monitor. The system sounds a beep indicating the self test on alarm sounds is passed. The alarm lamps light red, yellow and cyan respectively, and then go off, indicating the self test on alarm is passed.
3. The patient monitor enters the main screen and start-up is finished.

4.4 Module Performance Tests

4.4.1 ECG Tests

ECG Performance Test

Tools required:

- Medsim300B patient simulator

1. Connect the patient simulator with the ECG module using an ECG cable.
2. Set the patient simulator as follows: ECG sinus rhythm, HR = 60 bpm with the amplitude as 1 mV.
3. Verify that the ECG waves are displayed correctly without noise and the displayed HR value is within 60±1 bpm.
4. Disconnect each of the leads in turn and observe the corresponding lead off message displayed on the screen.
5. Set the output of the simulator to deliver a paced signal and set Paced to Yes on the monitor. Check the pace pulse marks on the monitor screen.

ECG Verification

Tools required:

- Vernier caliper

1. Select the ECG parameter window or waveform area→**Filter**→**Diagnostic**.
2. Select **Main Menu**→**Maintenance**→enter the required password→**Module**.
3. Select **Calibrate ECG**. A square wave appears on the screen and the message ECG Calibrating is displayed.
4. Compare the amplitude of the square wave with the wave scale. The difference should be within 5%.
5. After completing the calibration, select **Stop Calibration**.

If necessary, you can print out the square wave and wave scale through the recorder and then measure the difference.

4.4.2 Resp Performance Test

Tools required:

- Medsim300B patient simulator

1. Connect the patient simulator to the module using a non ESU-proof cable and set lead II as the respiration lead.
2. Configure the simulator as follows: lead II as the respiration lead, base impedance line as 500 Ω; delta impedance as 1 Ω, respiration rate as 20 rpm.
3. Verify that the Resp wave is displayed without any distortion and the displayed Resp value is within 20±1 rpm.

4.4.3 SpO_2 Test

Tools required:

- None.

1. Connect SpO_2 sensor to the SpO_2 connector of the monitor. Set Patient Category to Adult and PR Source to SpO2 on the monitor.
2. Apply the SpO_2 sensor to the ring finger of a healthy person.
3. Check the Pleth wave and PR reading on the screen and make sure that the displayed SpO_2 is within 95% and100%.
4. Remove the SpO_2 sensor from your finger and make sure that an alarm of SpO_2 Sensor Off is triggered.

Measurement accuracy verification:

The SpO_2 accuracy of the MPM module has been verified in human experiments by comparing with arterial blood sample reference measured with a CO-oximeter. Pulse oximeter measurements are statistically distributed and about two-thirds of the measurements are expected to come within the specified accuracy range compared to CO-oximeter measurements.

NOTE

- **A simulator cannot be used to assess the accuracy of a pulse oximeter monitor or a SpO_2 sensor. Instead, it can only verify that whether the monitor is functional. The accuracy of a pulse oximeter monitor or a SpO_2 sensor needs to be verified by clinical data.**

4.4.4 NIBP Tests

See section ***4.2.24.2.2NIBP Tests***.

4.4.5 Temp Test

Tools required:

- Resistance box (with accuracy above 0.1 Ω)

1. Connect the two pins of any Temp connector of a module to the two ends of the resistance box using two wires.
2. Set the resistance box to 1354.9 Ω (corresponding temperature is 37ºC).
3. Verify each Temp channel of the monitor and make sure that the displayed value is within 37±0.1ºC.

4.4.6 IBP Tests

Performance Test

Tools required:

- Medsim300B patient simulator, MPS450, or other equivalent equipment
- Dedicated IBP adapter cable (300B, P/N 00-002199-00) (use P/N 00-002198-00, if the simulator is MPS450)

1. Connect the patient simulator to the monitor's IBP connector.
2. Set the patient simulator output to the IBP channel to 0 mmHg.
3. Press the Zero key on the module to make a zero calibration.
4. Set static pressure to 200 mmHg on the patient simulator.
5. The displayed value should be within 200±2 mmHg.
6. If the value is outside of these tolerances, calibrate the IBP module. If the IBP module was calibrated with a dedicated reusable IBP sensor, check the calibration together with this IBP sensor.
7. Make the patient simulator outputs 120/80 mmHg ART signals and 120/0 mmHg LV signals respectively to each IBP channel and check that the IBP wave is displayed correctly.

Pressure Calibration

Method 1:

Tools required:

- Medsim300B patient simulator, MPS450, or other equivalent equipment
- Dedicated IBP adapter cable (300B, P/N 00-002199-00) (use P/N 00-002198-00, if the simulator is MPS450)

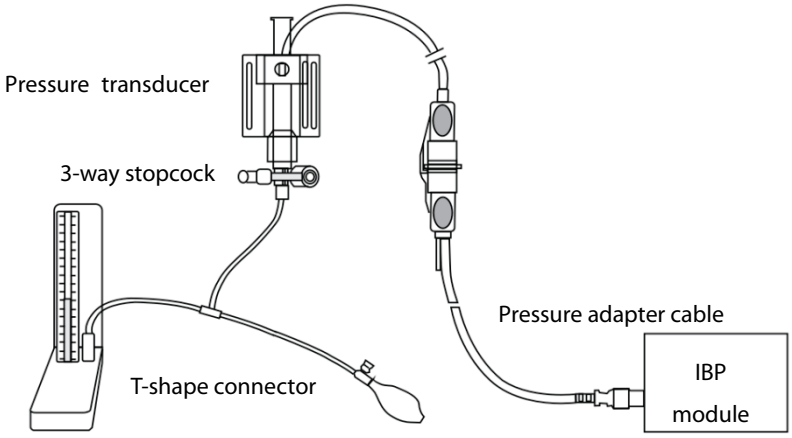
1. Connect the patient simulator to the monitor's IBP connector.

2. Set the patient simulator to 0 pressure for the desired IBP channel.
3. Press the Zero key on the module to make a zero calibration.
4. Set static pressure to 200 mmHg on the patient simulator.
5. Select **Main Menu**→**Maintenance**→enter the required password→**Module**→**IBP**. In the **Cal. IBP Press.** menu, set the calibration value to 200 mmHg.
6. Select the **Calibrate** button next to the desired IBP channel to start a calibration.
7. If the calibration is completed successfully, the message **Calibration Completed!** will be displayed. Otherwise, a corresponding message will be displayed.

Method 2:
Tools required:

- Standard sphygmomanometer
- Squeeze bulb
- Tubing
- T-shape connector

1. Connect the 3-way stopcock, the sphygmomanometer and the squeeze bulb through a T-shape connector, as shown below.
2. Zero the transducer, and then open the stopcock to the sphygmomanometer.



3. Select **Main Menu**→**Maintenance**→enter the required password→**Module**→**IBP**. In the displayed interface, set the target calibration value of the target channel. Value range: 80 to 300 mmHg.
4. Inflate using the squeeze bulb until the reading of sphygmomanometer approximates the preset calibration value.
5. Adjust the calibration value in the **Maintain IBP** menu until it is equal to the reading of sphygmomanometer
6. Select the **Calibrate** button next to the desired IBP channel to start a calibration.

If the calibration is completed successfully, the message **Calibration Completed!** will be displayed. Otherwise, a corresponding message will be displayed.

4.4.7 C.O. Test

Tools required:

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

1. Connect the patient simulator to the C.O. module using a C.O. main cable.
2. Set the blood temperature (BT) to 37ºC on the patient simulator and check the temperature value is 37±0.1ºC.
3. Switch off Auto TI and adjust TI (IT) to 24ºC. Select C.O. Measure to enter the C.O. measurement window and set **Comp. Const.** to 0.595.
4. Set the injectate temperature to 24ºC and the C.O. to 5 L/min on the C.O. simulator. Select **Start** in the C.O. measurement window to start C.O. measurements, and press the run key on the simulator after 3-10 seconds.
5. Verify that the C.O. value is 5±0.25 L/min.

4.4.8 Mainstream CO_2 Tests

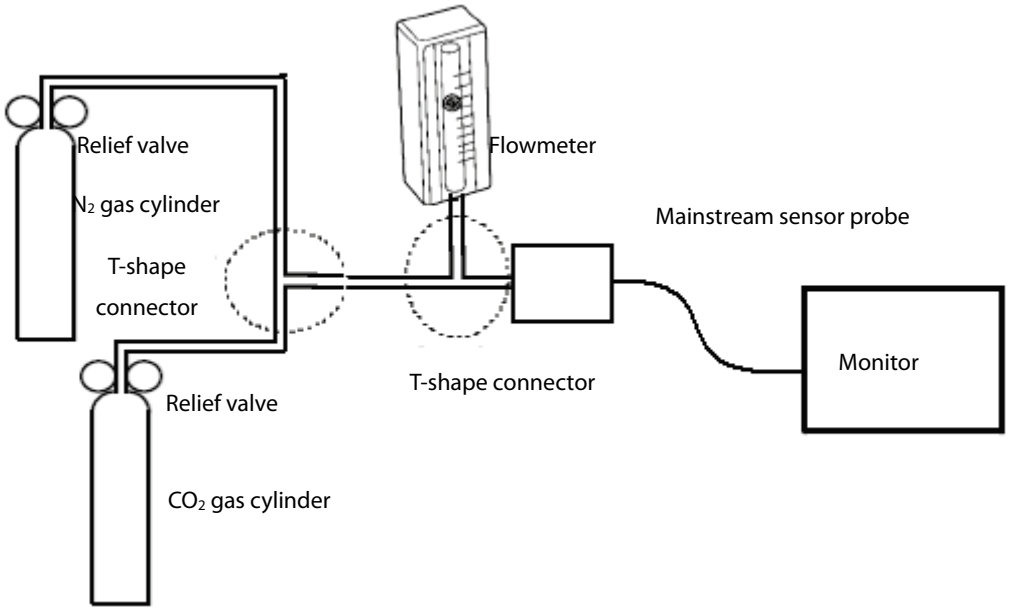
NOTE

- **Make sure that the barometric pressure set in Main Menu→Maintenance→enter the required password→Other accords with the local barometric pressure before performing mainstream CO_2 tests.**

Tools required:

- A steel gas cylinder with 6±0.05% CO_2 and balance gas N_2
- A steel gas cylinder with100% N_2
- T-shape connector
- Tubing
- Flowmeter

1. Plug the module into the module rack and connect the sensor.
2. Wait until CO_2 warmup is finished. Select the CO_2 waveform or parameter to enter the **CO2 Setup** menu. Then, select **Start Zero Cal.** to start a zero calibration. If the zero calibration fails, the prompt message **CO2 Zero Failed** is displayed. Otherwise, the baseline of waveform recovers to zero.
3. Set **Apnea Time** to 10s in the **CO2 Setup** menu.
4. Blow to the CO_2 sensor to generate a CO_2 waveform and then place the sensor in the air. Check if the alarm message ***** Apnea** is displayed on the screen.
5. Connect the test system as follows:



6. Turn on the relief valves of N_2 gas cylinder and CO_2 cylinder respectively to ensure that only one gas cylinder is connected to the T-shape connector at a time.
7. Adjust the relief valves respectively to ensure a stable flow by maintaining the reading on the flowmeter at a value between 2 and 5 L/min.
8. Switch between the two cylinders to connect Mainstream CO_2 sensor at intervals of 6 -10s and check if the displayed CO_2 value is 45±2 mmHg.

4.4.9 Sidestream and Microstream CO_2 Tests

See section ***4.2.3Sidestream and Microstream CO2 Tests***.

4.4.10 AG Tests

See section ***4.2.4AG Tests***.

4.4.11 EEG Test

You can choose either of the following methods to perform the test:

Method 1:

Tools required:

- ECG simulator with Sine wave output function.

1. Connect pins of EEG lead wires to an ECG simulator.

   Set the ECG simulator to output Sine wave and frequency to between 0.5 and 30Hz. The range is 2mV. The GND pin of EEG module connects to RL of ECG simulator. The A+ pin of EEG module connects to LA of ECG simulator. The other pins of EEG lead wires connect to any ECG lead as you wish.
2. Open the EEG setting menu on monitor, Set the **Scale of EEG** to be 2000uV. Then you can find a Sine wave on screen of Patient Monitor.

Method 2:

Tools required:

- None.

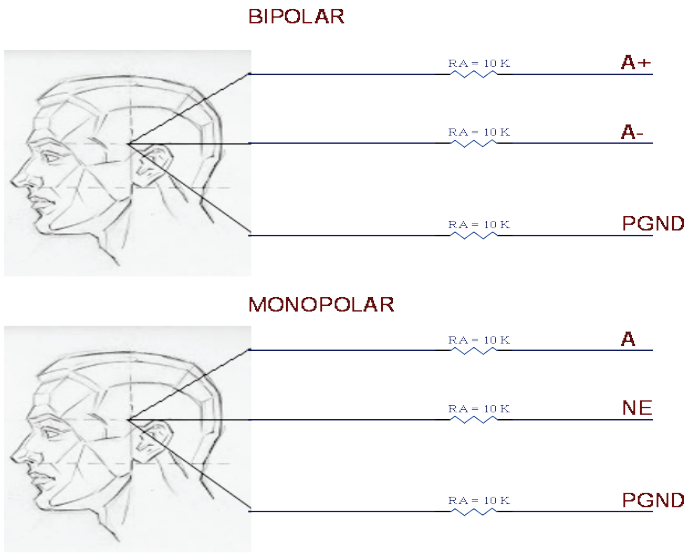
Connect all the pins of EEG lead wire together, for example, you can connect them to some metal materials. Then check the EEG module resistance test, if all the leads are green then pass.

Method 3:

Tools required:

- Resistance box
- Multimeter

1. Connect the EEG module/cable to the EEG simulator and the monitor.
2. Set Montage Type: Bipolar Mode.
3. Adjust the resistance box to 1 kΩ, verify the resistance value displayed on the monitor is 1kΩ.
4. Test the lead type of the monitor to B+, C+ and D+ respectively instead of lead A+.
5. Set Montage Type: Monopolar Mode , then repeat the step 3~4.



EEG Module (Self-made Module)

You can perform the test by any one of the following methods:

Method 1:

Test tools: ECG simulator that supports sine wave output

1. Connect the EEG lead to the ECG simulator.

   Configure the ECG simulator as follows: output of sine wave, output frequency of 0.5–30Hz, and output amplitude of 2mV. Connect the EEG's PGND lead to the RL lead interface of the ECG simulator, the EEG's EEG1+ lead to the LA lead interface of the ECG simulator, and other EEG leads to random interfaces of the ECG simulator.

2. On the EEG menu of the monitor, set the EEG input range to 2000uV. If a sine wave is displayed int he EEG waveform area on the monitor screen, the EEG module is functional.

Method 2:

Test tools: None

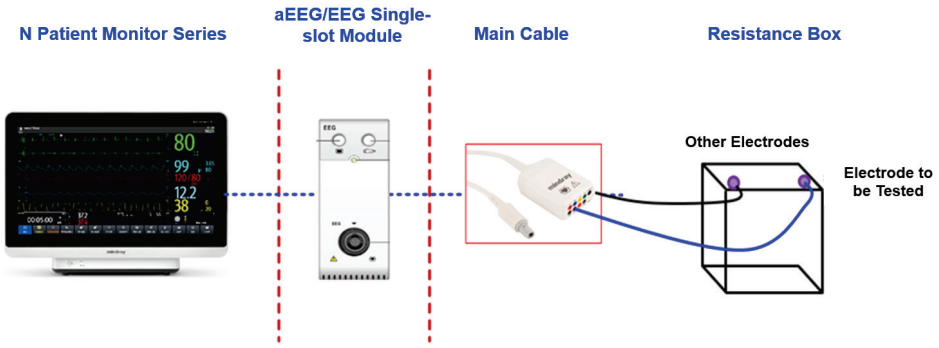
Connect all EEG leads together, for example, connect them to the same conducive metal object. Then, in the EEG module settings on the monitor, select impedance test. The electrode impedance is displayed. If the impedance of all leads is 0 or 1, the EEG module is functional.

Method 3:

Test tools:

- Resistance box

1. Connect the EEG module/cable, ECG simulator and monitor. Connect the electrode to be tested to one end of the resistance box, and other electrodes to the other end of the resistance box.
2. Set Montage mode to Bi-Polar.
3. Set the resistance box impedance to 5kΩ. Check whether the impedance displayed on the monitor is 5±1kΩ.
4. Test EEG1+, EEG2+, EEG3+ and EEG4+ respectively.
5. Set Montage mode to Uni-Polar. Repeat steps 3 and 4.



4.4.12 BIS Test

You can choose either of the following methods to perform the test:

Method 1:

Tools required:

- None.

1. Connect the BIS sensor to a healthy, wide-awake adult as directed in the Operator's Manual.
2. Check the EEG wave and BIS numerics displayed on the screen and make sure the BIS value is within 80 and 100.

Method 2:

Tools required:

- BIS simulator (Covidien PN: 186-0137)

1. Connect the BIS sensor with the BIS simulator. Select BIS area parameter or waveform to access BIS Setup. Then, select Sensor Check to perform a cyclic impedance check.
2. After the cyclic impedance check is finished, check that the result for each electrode is passed.

Method 3:

Tools:

- Signal generator, (Maker: NF, Model:WF1946B)
- Covidien Signal simulator (Covidien PN:189-0137)

1. Insert the BIS module to the monitor, connect the BIS module/cable to the Covidien Signal simulator, signal generator.
2. Adjust the signal generator to produce a 90Hz, 35.4mV(RMS) sine signal to the Convidien Signal simulator.
3. Set the time length of the review window to the shortest.
4. Verify the EMG value range from 65 to 75, and SQI value should be 100 displayed on Graphic Trends.

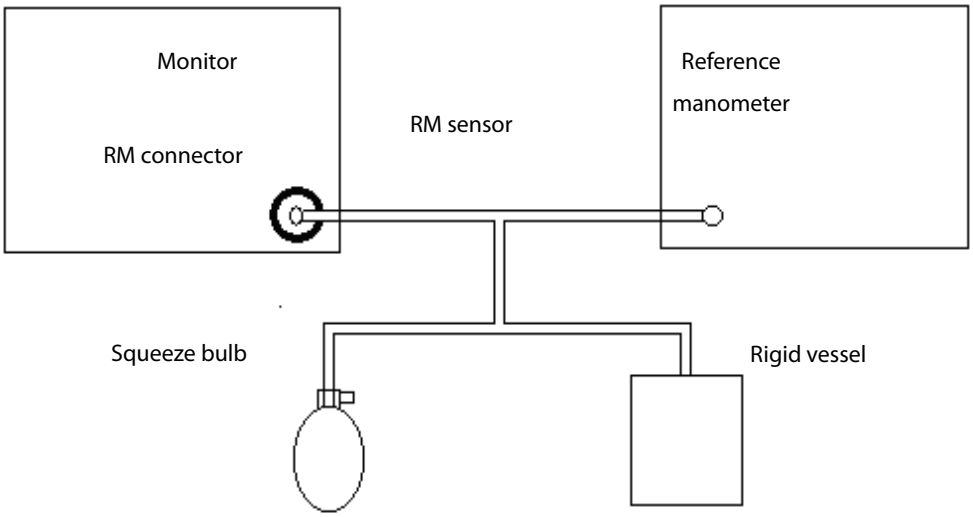
4.4.13 RM Test

Method 1:

Tools required:

- T-shape connector
- Tubing
- Squeeze bulb
- Rigid vessel with volume 500±25 ml
- Reference manometer (calibrated with accuracy equal to or greater than 1 mmHg)
- Flow sensor for adult patient

1. Connect the equipment as shown below.
2. Set the monitor to be tested to mechanical ventilation mode.
3. Use the squeeze bulb to exert a test pressure of 60cmH_2O, and check whether the RM airway pressure precision meets the requirement of 58.2~61.8cmH_2O.

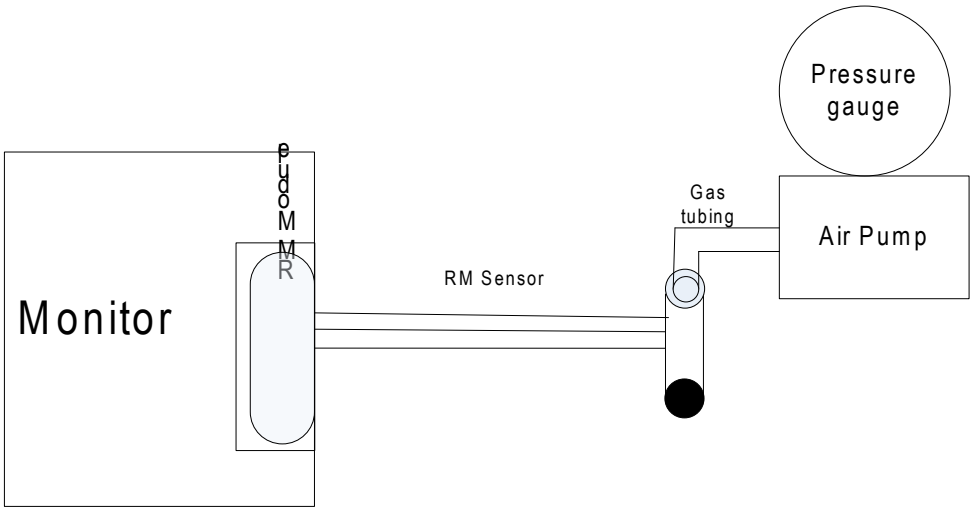


Method 2:

Tools required:

- Tubing
- Pressure gauge (Accuracy not less than 0.1cmH_2O)
- Air Pump (-95~400 kPa)

1. Connect the module, RM sensor, air pump and pressure gauge according to picture below.
2. Select monitor as mechanical ventilation mode.
3. Use air pump to inflate to -20, 0, 10, 60, 120cmH_2O pressure, verify RM module measured airway pressure accuracy is ±3% of reading.



4.4.14 CCO/SvO_2 Tests

Interconnecting Function

Tools required:

- None.

1. Connect and set the patient monitor and Vigilance monitor per the procedures in the Operator's Manual.
2. Set the Vigilance monitor to Demo mode. Start the CCO and SvO_2 tests in Demo mode.
3. Verify that the CCO/SvO_2 numerics displayed on the patient monitor and Vigilance monitor are consistent.

Output Performance

Tools required:

Multimeter

1. Connect the signal output end of the connecting cables of the CCO/SvO_2 module to the oscilloscope.
2. Select **CCO Setup→Signal Output Setup** and then select **Simulated High Value** from the pop-up menu. Check that the amplitude of electrical level at the signal output port of ECG, MAP, CVP and SpO_2 are 5±0.015 V, 5±0.25 V, 5±0.25 V and 10±0.5 V respectively.

4.4.15 PiCCO Test

Performance Test

Tools required:

- Medsim300B patient simulator or Prosim 8
- PiCCO IBP test cable (PN: 040-001300-00)

1. Connect the patient simulator, the PiCCO IBP test cable and the PiCCO module.
2. Let the patient simulator outputs 0 mmHg respectively to the pArt channel and the pCVP channel.
3. Select the pArt parameter interface to access the pArt Setup menu, and then select Zero.
4. Select the pCVP parameter interface to access the pCVP Setup menu, and then select Zero.
5. Let the patient simulator output static pressure 200 mmHg to pArt channel and 20 mmHg to pCVP channel.
6. The pArt value displayed on the monitor should be within 200±4 mmHg, and pCVP value within 20±1 mmHg.
7. If the pArt error is beyond ±4 mmHg or pCVP error beyond ±1 mmHg, calibrate the PiCCO module. If the module was calibrated with a dedicated reusable IBP sensor, check the calibration together with this IBP sensor.
8. Let the patient simulator output ART signal to the pArt channel and CVP signal to the pCVP channel, check whether the IBP waveform is correctly displayed.

Pressure Calibration

Method 1:

Tools required:

- Medsim300B patient simulator or Prosim 8
- PiCCO IBP test cable (PN: 040-001300-00)

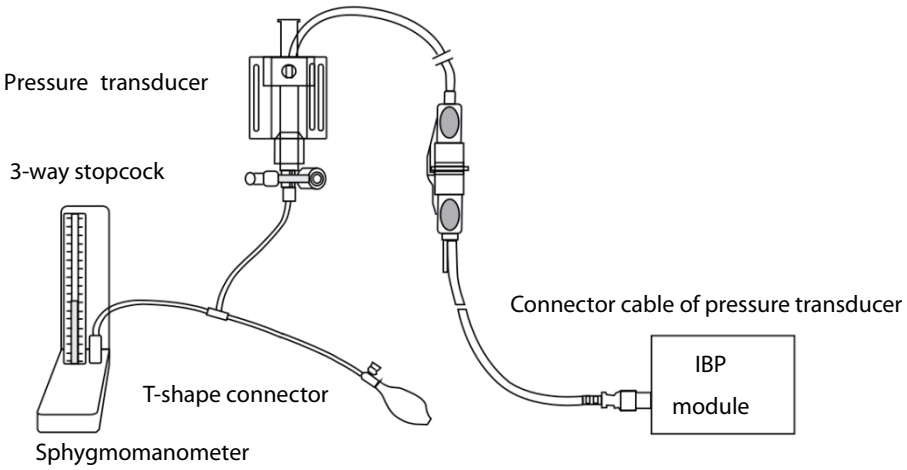
1. Connect the patient simulator, the PiCCO IBP test cable and the PiCCO module.
2. Let the patient simulator outputs 0 mmHg respectively to the pArt channel and the pCVP channel.
3. Select the pArt parameter interface to access the pArt Setup menu, and then select Zero.
4. Select the pCVP parameter interface to access the pCVP Setup menu, and then select Zero.
5. Set static pressure to 200 mmHg on the patient simulator.
6. Select **Main Menu**→**Maintenance**→enter the required password→**Module**. In the IBP menu, set the calibration pressure to 200 mmHg.
7. Select the **Calibrate** button next to the desired IBP channel to start a calibration.

The message **Calibration Completed!** is displayed after a successful calibration. Otherwise, a corresponding message will be displayed.

Method 2:
Tools required:

- Standard sphygmomanometer
- Squeeze bulb
- Tubing
- T-shape connector

1. Connect the 3-way stopcock, the sphygmomanometer and the squeeze bulb through a T-shape connector, as shown below.
2. Turn on the 3-way stopcock to the air to zero the transducer, and then open the stopcock to the sphygmomanometer.



3. Select **Main Menu**→**Maintenance**→enter the required password→**Module**. In the IBP menu, set the target calibration value of the target channel.
4. Inflate using the squeeze bulb until the reading of sphygmomanometer approximates the preset calibration value.
5. Adjust the calibration value in the **Maintain IBP** menu until it is equal to the reading of sphygmomanometer.
6. Select the Calibrate button next to the desired IBP channel to start a calibration.

The message **Calibration Completed!** is displayed after a successful calibration. Otherwise, a corresponding message will be displayed.

C.O. Test

Method 1:

Tools required:

- Medsim300B Patient simulator or Prosim 8, or equivalent equipment
- C.O. adapter box (for 300B)
- PiCCO C.O. test cable (PN: 040-001301-00)

1. Connect the patient simulator and the C.O. module using a C.O. trunk cable and a C.O. adapter box.
2. Set the blood temperature (BT) to 37°C on the patient simulator and check the temperature value is 37±0.1°C.
3. Select CCO parameter interface to access the C.O. Measure interface. Then, select Setup to check whether the value of Catheter Type is PV2015L20.
4. Turn the injectate temperature (TI) knob on the C.O. adapter box to set the TI to 20±1°C for the patient simulator and C.O. to 5 L/min.
5. In the C.O. Measurement window, select **Start** to start C.O. measurement. As soon as the prompt Inject XXml is displayed, adjust TI to 4±1°C, and then quickly back to 20±1°C. Simultaneously press the button on the simulator that corresponds to 5 L/min. The whole procedure shall be finished in 10 seconds.
6. Verify that the C.O. value displayed on the monitor is correct.

Method 2:

Tools required:

- Medsim300B Patient simulator or Prosim 8, or equivalent equipment
- C.O. adapter box (for 300B)
- PiCCO C.O. test cable (PN: 040-001301-00)

1. Connect the patient simulator and the C.O. module using a C.O. trunk cable and a C.O. adapter box.
2. Set the blood temperature (BT) to 37°C on the patient simulator and check the temperature value is 37±0.1°C.
3. Select CCO parameter interface to access the C.O. Measure interface. Then, select **Setup** to check whether the value of **Catheter Type** is PV2015L20.
4. Turn the injectate temperature (TI) knob on the C.O. adapter box to check whether the value of the TI is from 0 to 30°C.

4.4.16 NMT Tests

Performance Test

Method 1:

Tools required:

- Resistance box
- Multimeter

1. Set the resistance value to 1kOhm. Connect the stimulation electrodes to the two wiring terminals.
2. Set the multimeter to operate in DC mode. Connect the multimeter sensors to the NMT stimulation electrodes, making sure that the sensor and electrode connected have the same polarity.
3. Insert the NMT module into the module rack of the monitor. Select the NMT parameter area of the monitor to access the **NMT Setup** menu. Set the **Stimulation Current** to **Supra(60mA)**. Set the **Pulse Width** to **300μs**. Perform a PTC measurement.
4. Check the voltage change detected by the multimeter and verify normal output of NMT stimulation.

Method 2:

Tools required:

- Resistance box (0~9999.9 Ω)
- Oscilloscope (Agilent DS0-X3014A)

1. Set resistance box to 1kOhm, connect stimulation electrodes to the resistance box.
2. Insert the NMT module to monitor. Set **Stimulation current** to **Supra (35mA)**, **Pulse width** to **200μs**. Select **ST Mode** in **NMT setup** menu to start a ST measure.
3. Measure the voltage wave of the resistance box by oscilloscope, verify the pulse width is range from 180 to 220us, and calculate the Stimulation Current according stimulation voltage should be range from 33 to 37mA.

Sensor Check

Tools required:

- None.

1. Connect the patient monitor, NMT module, and NMT accessories.
2. Select **Main Menu**→**Maintenance**→enter the required password→**Module**→**NMT**.
3. Follow the on-screen instructions to check the NMT sensor.

If sensor check completes successfully, the message **Test passed. The function of NMT sensor is OK** is displayed, indicating a functional sensor. If the check fails, check whether the sensor is placed correctly as instructed, and perform the sensor check again.

NOTE

- **Stop NMT measurement or calibration before starting NMT sensor check.**
- **Avoid forcefully striking the sensor.**

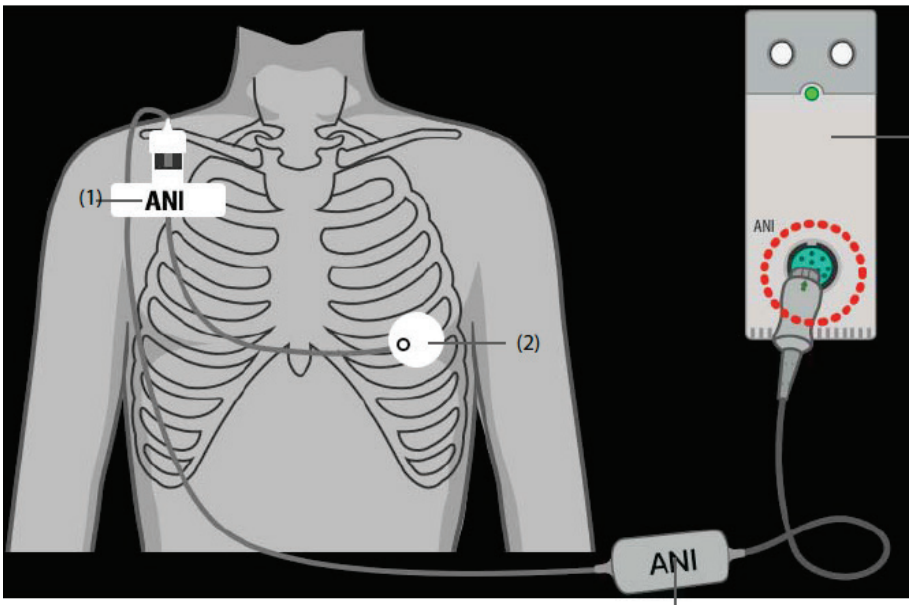
4.4.17 ANI Test

Method 1: Using ANI sensor

Test tools:

- ANI sensor

1. Follow instructions in the ANI module chapter in the user manual to connect the ANI measurement system. Follow instructions in ANI sensor user manual to connect the ANI sensor to a healthy adult.



2. After three minutes, observe the ANI parameter value displayed on the monitor interface. If the ANI parameter value is within the range of [12,100], the ANI module is functional.

Method 2: Using Simulator

Test tools:

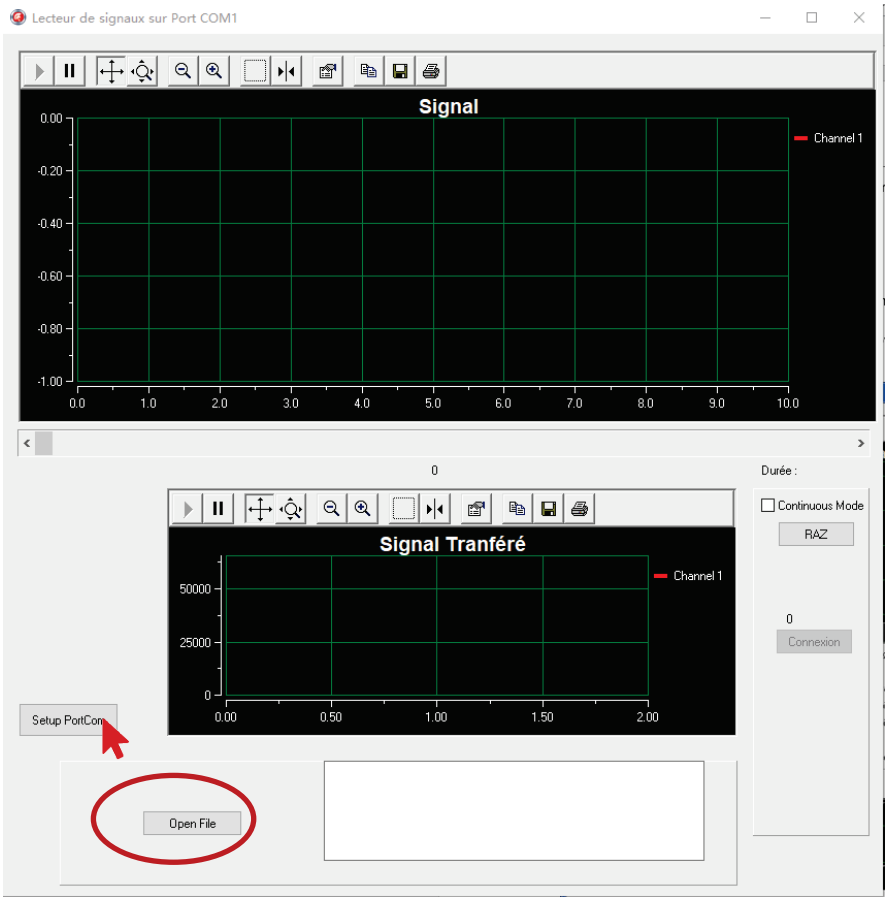
- ANI simulator
- PC (with software and drive G-897-000275-00 installed)

1. Follow instructions in the ANI module chapter in the user manual to connect the ANI measurement system (ANI sensor does not need to be connected).
2. Connect one end of the ANI simulator to the ANI module, and the other end to the upper computer, as shown in the following figure.

Upper computer

3. Log in to the PC, install the configuration software G-897-000275-00: Open the PC software & drive folder under the G-897-000275-00 folder, and double-click to install the CDM21224_Setup drive. After installation is completed, start

the SimuEcgMindray software. The main interface is displayed, as shown in the following figure. Click Setup PortCom for parameter configuration. Set the port; for other parameters, use the default settings. For information about the port, go to Device Manager → Ports (COM & LPT) → USB Serial Port.



4. After parameter configuration, input the file of the corresponding ANI value: Click Open File on the main interface (as shown in the red circle in the above figure), and select \\ G-897-000275-00\waveform data file\ SIGNAL_ANI_60 (ANI value is 60).
5. Running: Click Connexion on the main interface of the upper computer to complete running. After three minutes, observe the ANI parameter value (ANIi and ANIm) displayed on the monitor interface. If the ANI parameter value is within the range of [57,63], the ANI module is functional.

4.5 Nurse Call Relay Performance Test

Tools required:

- Multimeter

1. Connect the nurse call cable to the Nurse Call Connector of the patient monitor.
2. Enter Demo mode. Then, select **Main Menu→Maintenance >>→**enter the required password**→Alarm** to access the **Nurse Call setup** menu.
3. In **Nurse Call** menu, select all options of **Alarm Priority** and **Alarm Type.** and set **Contact Type** to **Normally Open**.

4. In **Nurse Call** menu, set **Signal Type** to **Pulse**. Cause the monitor to generate an alarm and verify the output are pulses of 1s width and the relay contacts are closed (can be measured with a multimeter) when there is an alarm.
5. In **Nurse Call** menu, set **Signal Type** to **Continuous**. Cause the monitor to generate an alarm and verify the output is continuous high level and the relay contacts are closed (can be measured with a multimeter) when there is an alarm.

4.6 Analog Output Performance Test

Tools required:

- Patient simulator
- Oscilloscope

1. Connect the patient simulator to the monitor using an ECG or IBP cable and connect the oscilloscope to the Auxiliary Output Connector of the MPM module of the patient monitor.
2. Verify that the waves displayed on the oscilloscope are identical with those displayed on the monitor.

4.7 Electrical Safety Tests

⚠WARNING

- **Electrical safety tests are a proven means of detecting abnormalities that, if undetected, could prove dangerous to either the patient or the operator.**
- **All tests can be performed using commercially available safety analyzer test equipment. Maintenance personnel shall ensure the adaptability, functional completeness and safety of these pieces of test equipment, and be familiar with their usage.**
- **Electrical safety tests shall comply with the following standards: IEC 60601-1 and ANSI/AAMI ES60601-1.**
- **In case of other stipulations in local laws and regulations, implement electrical safety tests by following relevant stipulations.**
- **All devices driven by AC power and connected to medical instruments in patient zones must comply with the IEC 60601-1 standard. And electrical safety tests on these devices must be implemented in accordance with the test interval of the patient monitor.**
- **Use certified safety analyzer (for example, UL, CSA or AMAI) as instructed to perform relevant tests.**

NOTE

- **Electrical safety check shall be performed after repair or routine maintenance. Ensure that all cover boards, panels and screws are correctly installed before implementing electrical safety tests.**
- **Electrical safety tests are used to timely detect potential electrical safety risks that might cause damage to patients, operators or maintenance personnel. Electrical safety tests must be carried out under normal environmental conditions (that is, normal temperature, humidity and barometric pressure).**

See ***Appendix A Electrical Safety Inspection*** for electrical safety tests.

4.8 Recorder Check

Tools required:

- None.

1. Print ECG waveforms. The recorder should print correctly and the printout should be clear.
2. Set the recorder to some problems such as out of paper, etc. the patient monitor should give corresponding prompt messages. After the problem is removed, the recorder should be able to work correctly.
3. Switch automatic alarm recording for each parameter ON and then set each parameter's limit outside set alarm limits. Corresponding alarm recordings should be triggered when parameter alarms occur.

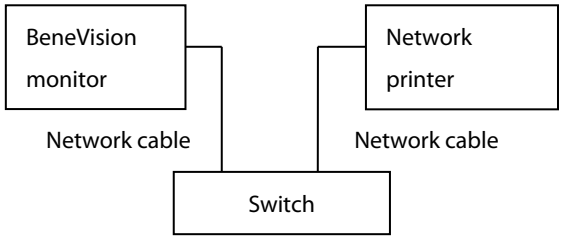
4.9 Network Print Test

NOTE

- **HP LaserJet Pro M202dw laser printer is recommended for BeneVision patient monitor series**

4.9.1 Device Connection and Setup

1. Connect the patient monitor and network printer to a network switch using common network cables as follows:



2. Select **Main Menu**→**Maintenance**→enter the required password→**Network Setup** and set the IP address of the patient monitor in the same network segment with that of the network printer. (See the instructions for use accompanying the printer)
3. Select **Main Menu**→**Maintenance**→enter the required password→**Print** and set the IP address of the printer to the actual IP address, and set the paper size to the actual size.
4. Set the print resolution to 300dpi or 600dpi as required.
5. Click **Print Test Page** to check whether the output of the printer's test page is normal. If not, recheck the connection and configuration of the printer.

4.10 Device Integration Check

Refer to BeneLink Module Operator's Manual (P/N: 046-009023-00).

4.11 Battery Check

Tools required:

- None.

Function Test

1. Verify that the patient monitor works properly when running on AC power.
2. Remove the AC power cord and verify that the patient monitor still works properly.

Performance Test

Perform the test procedure in the ***Battery*** section in the Operator's Manual and verify the operating time of the battery meets the product specification.

4.12 Mounting Check

Tools required:

- None.

4.12.1 Safety check

Check the mounting of Patient Monitor is safe.

4.12.2 Overall Test and Check of Installed System

Implement installation test:

The following tests and checks need to be performed after a patient monitor is installed, or reinstalled after being disassembled and repaired:

- Check that the screws fastening the bracket and guide rail are not loose.
- Check that the five installation screws on the bottom side of the N12/M12 monitor are not loose.(six installation screws for N15/M15 and N17/M17)
- Check that the four installation screws on the transfer metal and monitor bottom side are not loose.
- Check that it can be installed in place and locked when N12 monitor use fast lock installed way
- Check that it can be installed in place and locked when the monitor use on the cart installed way
- Check that the modules can be normally and securely inserted into the module rack.
- Check that the trim strip is properly installed after the display is disassembled and repaired.
- Check that the monitor handle is not loose.
- Check that the VHM bracket can place the monitor at any height as required.

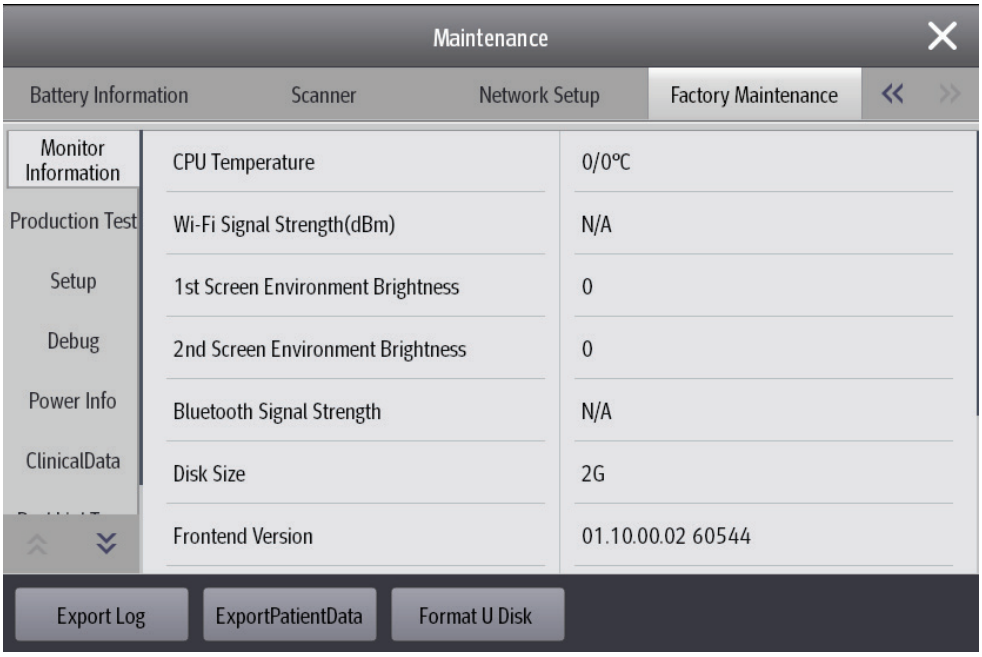
4.13 Factory Maintenance

4.13.1 Accessing Factory Maintenance Menu

Select **Main Menu→Maintenance** (input the correct password)→**Factory Maintenance** to open the **Factory Maintenance** menu.

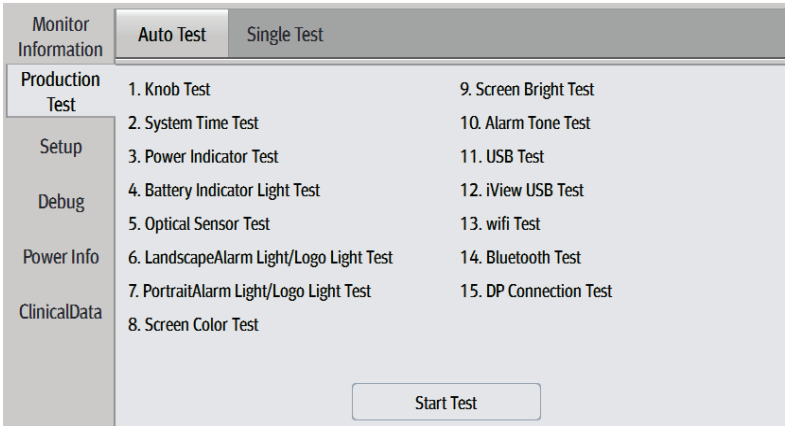
4.13.2 Monitor Information

You can view the information about the patient monitor and export the log to a USB disk.



4.13.3 Production Test

This tab page lists the basic functions of major hardware interfaces of the monitor. Production test can be classified into auto test and single test. If auto test is selected, the system will automatically complete all the tests in sequence; for single test, users can select a specific test as required. The test interface is shown in the following figure.



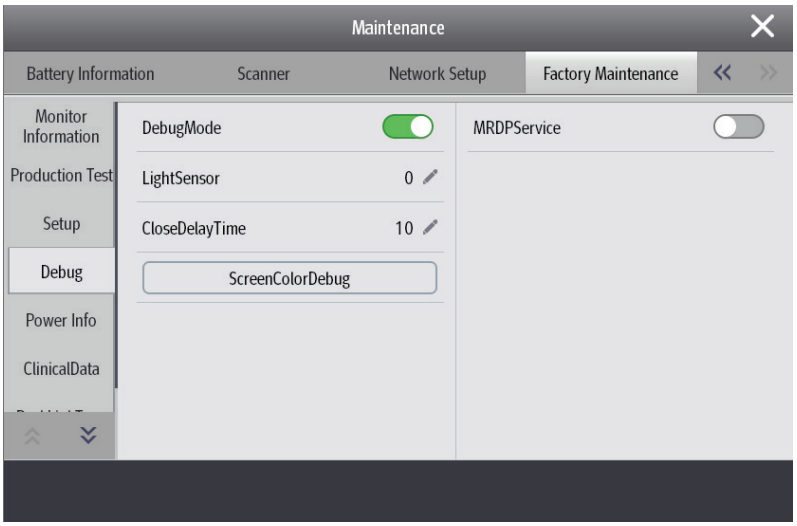
4.13.4 Setup

This tab page supports the settings relevant to ECG alarms and other configurations.

- Neonate ST analysis switch: Switch it on to enable the neonate ST analysis function; switch it off to disable relevant functions of neonate ST analysis.
- HR/PR alarm off switch: Switch it on to set the HR/PR alarm switch; switch it off to disable the setting of HR/PR alarm switch.
- HR alarm delay switch: Switch it on to enable the HR alarm affected by the setting of alarm delay; switch it off to prevent the HR alarm from being affected by the setting of alarm delay.
- ESN: Enter the electronic serial number.
- Wireless setting: Provide Wi-Fi regulation test procedure and settings.
- Update ID Module: Provide interface for burning device integration ID. Users should confirm the BeneLink port and device ID before burning.

4.13.5 Debug

This tab page provides settings related to the debug mode, which is only applicable to testing.

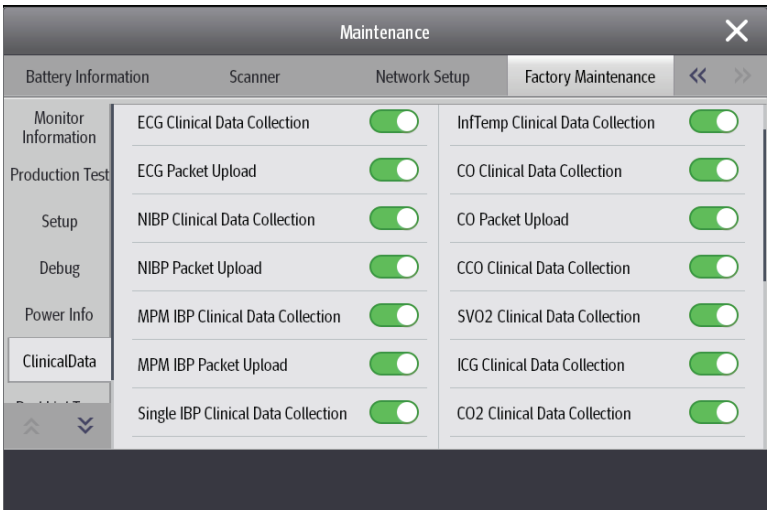


4.13.6 Power Info

This tab page displays information about power supply.

4.13.7 ClinicalData

This tab page provides settings related to clinical data collection.



- Clinical Data Location: Supports the settings of data storage location. (None indicates not stored; Local indicates saving locally; and Udisk indicates saving in a USB disk.)
- Each parameter module provides independent parameter collection switch.

NOTE

- **The recorder is disabled if** Recorder **is switched off in the** Factory Maintenance **menu.**

4.13.8 Transferring Clinical Data

In the **Factory Maintenance** page, select **Clinical Data Transfer**. Select data you want to transfer.

4.13.9 Software Version

In the Factory Maintenance menu, select **Software Version** to show software version information.

4.13.10 Monitor Information

In the Factory Maintenance menu, select Monitor Information to show the status of the patient monitor.

Maintenance and Test Report

(See the above sections for detailed test procedures and contents)

Customer name			
Customer address			
Servicing person			
Servicing company			
Equipment under test (EUT)			
Model of EUT			
SN of EUT			
Hardware version			
Software version			
Test equipment	**Model/No.**	**Effective date of calibration**	
Test items		**Test records**	**Test results(Pass/Fail/NA)**
Visual Inspection			
The case, display screen, buttons, handle, SMR, modules, power cord, wall-mount bracket and accessories have no obvious signs of damage.			
The external connecting cables are not frayed and the connector pins are not loose and bent.			
The external connectors are not loose or their pins are not bent.			
The safety labels and data plate are clearly legible.			
Power on test			
The power-on test is passed. The power indicator and alarm system work correctly and the monitor start up properly.			
Performance test			
ECG performance test			
ECG waves are displayed correctly without noise and the HR value is within 60±1 bpm.			
ECG Lead Off alarm behaves correctly.			
Paced signals are detected and pace pulse marks are displayed when Paced is set to Yes.			
The difference between the amplitude of the ECG calibration square wave and that of the wave scale is not greater than 5%.			
Resp test			
The Resp wave is not distorted and the Resp value is within 20±1 rpm.			
SpO_2 test			
Measure SpO_2 on a healthy person's finger and a Pleth wave and PR value are displayed. The displayed SpO_2 value is within 95%-100%.			
SpO_2 Sensor Off alarm behaves correctly.			
NIBP test			

The difference is within ±3 mm when 0, 50 or 200 mmHg is set for NIBP accuracy test.		
There is no leakage with NIBP, or the manual leakage test result does not exceed 6mmHg/min.		
Temp test		
The value displayed for each Temp channel of the monitor is within 37±0.1ºC.		
IBP test		
The static pressure value displayed for each IBP channel is within 200±2 mmHg.		
The ART and LV waves for each IBP channel are displayed correctly.		
C.O. test		
The TB value displayed on the monitor is within 37±0.1ºC.		
The displayed C.O. value is within 5±0.25 L/min.		
Mainstream CO_2 test		
The mainstream CO_2 is zeroed successfully and the waveform baseline recovers to zero.		
CO_2 Apnea alarm behaves correctly.		
The displayed CO_2 value is 45±2 mmHg.		
Sidestream CO_2 test		
Block the gas inlet of the module or watertrap. The sidestream CO_2 flowrate is slower than 10ml/min and an alarm of **CO2 Airway Occluded** is given. It indicates that there is no leakage.		
The displayed CO_2 value is 6±0.05%.		
The displayed O_2 value is within ±2% (when O2≤80%) or ±3% (80%≤O2≤100%)		
Microstream CO_2 test		
Block the gas inlet of the module or watertrap for about 30 seconds. An alarm of **CO2 Airway Occluded** is given. It indicates that there is no leakage.		
The displayed CO_2 value is 45±2 mmHg.		
AG test		
When AG flowrate is slower than 10ml/min, an alarm of AG Airway Occluded is given. It indicates that there is no leakage.		
The measurement accuracy of CO_2, N_2O, O_2 and AA (AA represents an anesthetic agent) meets the product specifications in the Operator's Manual.		
EEG test (you can select either method to perform the test)		
Method 1: The EEG wave is displayed on the monitor.		
Method 2: All the leads are green then pass in the EEG module resistance test.		
Method 3: The resistance values displayed on the monitor are 1kΩ		
BIS test (you can select either method to perform the test)		
Method 1: The BIS value measured on healthy, wide-awake adult is within 80-100.		

Method 2: The result of impedance check for each electrode is passed.		
Method 3: The EMG value range is from 65 to 75, and SQI value is 100 displayed on [Graphic Trends]		
RM test(you can select either method to perform the test)		
Method 1: The RM airway pressure is 58.2~61.8 cmH_2O.		
Method 2: The difference is within ±3% of reading when -20, 0, 10, 60, 120cmH2O is set for RM airway pressure accuracy test.		
CCO/SvO_2 test		
The CCO/SvO_2 numerics displayed on the patient monitor and Vigilance monitor are consistent.		
The waves (at the ECG signal output port) displayed on the oscilloscope are consistent with the ECG calibration waves displayed on the monitor screen.		
The amplitude of electrical level at the signal output port of MAP, CVP and SpO_2 are 5±0.25 V, 5±0.25 V and 10±0.5 V respectively.		
PiCCO test(you can select either method to perform the test)		
The pArt value displayed on the monitor is within 200±4 mmHg, and the pCVP value is within 20±1 mmHg.		
The waveforms of pArt and pCVP are displayed correctly.		
Method 1: The BT value is 37±0.1°C. The value of **CatheterType** is PV2015L20 The C.O. value is displayed on the monitor		
Method 2: The BT value is 37±0.1°C. The value of **CatheterType** is PV2015L20 The TI value is from 0 to 30°C		
NMT test(you can select either method to perform the test)		
Method 1: The voltage change is detected by the multimeter and the output of NMT stimulation is normal		
Method 2: The pulse width is range from 180 to 220us, and the calculated Stimulation Current is range from 33 to 37mA		
The sensor check is pass.		
EEG self-made module test (you can select one of these methods to perform the test)		
Method 1: Sine wave can be normally displayed.		
Method 2: It passes the impedance detection.		
Method 3: The impedance displayed on the monitor is 5±1kΩ.		
ANI test (you can select one of these methods to perform the test)		
Method 1: The ANI value measured on a healthy adult is within 12–100.		
Method 3: The impedance displayed on the monitor is within 57–63.		
Nurse call relay performance test		
The relay contacts are close when an alarm occurs.		
Analog output performance test		
The waves displayed on the oscilloscope are identical with those displayed on the monitor.		
Electrical safety test		
The Power Plug and cord check is passed.		

The Visual Inspection of Device Enclosure and Accessories is passed.		
The Contextual Inspection of Device Enclosure and Accessories is passed.		
the Main unit label and Integrated warning labels are present and legible		
The Protective Earth Resistance test is passed		
The Earth Leakage Test is passed		
The Patient Leakage Current test is passed		
The Mains on Applied Part Leakage test is passed		
The Patient Auxiliary Current test is passed		
Recorder check		
The recorder can print ECG waves correctly and the printout is clear.		
Set the recorder to some problems such as out of paper, etc. the patient monitor should give corresponding prompt messages. After the problem is removed, the recorder should be able to work correctly.		
Automatic alarm recording for each parameter functions correctly when parameter alarms occur.		
Network print test		
The output of the printer's test page is normal.		
Device integration check		
Devices Integrated window can display the type of the external device, ventilation mode, and corresponding parameters normally.		
Battery check		
The monitor can operates correctly from battery power when an AC power failure accidentally occurs.		
The operating time of the battery meets the product specification.		
Mounting Check		
The screws fastening the bracket and guide rail are not loose		
The five installation screws on the bottom side of the N12/M12 monitor are not loose.(six installation screws for N15/M15 and N17/M17)		
The four installation screws on the transfer metal and monitor bottom side are not loose		
It can be installed in place and locked when N12 monitor use fast lock installed way		
The modules can be normally and securely inserted into the module rack		
The trim strip is properly installed after the display is disassembled and repaired		
The VHM bracket can place the monitor at any height as required		

Conclusion:

Qualified or not: (Yes No)

Signature of tester: Date:

5 Troubleshooting

5.1 Introduction

This chapter lists the problems that may occur during use of the monitor and recommended measures. Refer to the table in this chapter to check the monitor, and confirm and fix these problems. For more information about the troubleshooting, please contact the after-sales service department of Mindray.

5.2 Part Replacement

For the monitor, the PCB, main parts and components can be replaced. For the LCD or touch screen fault, only the front case assembly can be replaced. Once the faulty PCB is confirmed, replace the PCB according to the operation guide in ***Chapter 7 Repair and Disassembly***. Then, confirm that the monitor can operate normally and has passed all the performance tests. For the information about replaceable parts, refer to ***Chapter 8 Parts***.

5.3 Check before Powering on the Monitor

After the AC power supply is connected, check whether the AC indicator is turned on. If not, confirm whether the AC cable is connected to the socket and monitor reliably. If both the AC external power supply and power cord are connected normally, but the AC indicator is off, the AC-DC power module or main control board of the main unit may be damaged. Now, you need to insert a battery to see whether the monitor can be powered on. If it cannot be powered on, the main control board may be damaged or the internal board is abnormal, resulting in power supply protection. If the monitor can be powered on, the AC-DC power module is damaged.

In addition, check the appearance for damages before powering on. Particularly, when the touch screen of the screen assembly is damaged, stop using the monitor immediately.

5.4 Software Version Check

Some troubleshooting tasks may involve software version compatibility. For information about the configuration and software version of your patient monitor, contact Mindray After-sales Service. To check the software version, do as follows:

1. Select **Main Menu→System >>→Version Information >>**. In the displayed menu, you can check the version information of the system software.
2. Select **Main Menu→System >>→Maintenance >>**→enter the user's maintenance password→**Version Information >>**. In the displayed menu, you can check the version information of the system software and modules.

5.5 Technical Alarm Check

Before troubleshooting the patient monitor, check for technical alarm message. If an alarm message is presented, eliminate the technical alarm first.

Message	Severity	Alarm Clearing	Causes and Countermeasures
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.
Switch does not support auto retrieving bed No.	Low	Cannot be cleared	Replace the switch with another one that supports CDP or LLDP.
Failed to auto retrieve bed No. information	Low	Cannot be cleared	Check whether the monitor is connected with the Masterserver; on the Masterserver, confirm that the interface for monitor connection is configured with bed No. binding.
Monitor Version Low	Low	Can be cleared	The N Series system software version is too low. In order for the N Series monitor to connect to the N1 which connects to the external IBP module and perform IBP monitoring, the system software of N 1 and N series monitor should be V02.25 and above.
XX V overvoltage	High	Cannot be cleared	Restart the machine. If the problem persists after restart, the power may be faulty. In this case, replace the main control board or power supply board.
XX V undervoltage	High	Cannot be cleared	Restart the machine. If the problem persists after restart, the power may be faulty. In this case, replace the main control board or power supply board.
Battery temperature too high	High	Cannot be cleared	Check whether the ambient temperature exceeds the allowable operating range; if not, the battery may be faulty. In this case, replace the battery.
Incorrect number	Low	Cannot be cleared	Check the number of batteries.

Message	Severity	Alarm Clearing	Causes and Countermeasures
of batteries			
Transport module battery is pulled out	High	Cannot be cleared	Restart the machine. If the problem persists after restart, the battery may be faulty. In this case, replace the battery.
Transport module battery is aged, replace the battery	Low	Audible and visual display can be cleared	Replace the battery.
Error reading dock E2PROM	High	Cannot be cleared	Re-plug N1/T1 (pay attention to align the pins). If the problem persists, accessing Factory Maintenance Menu to format dock EEPROM. Then, perform crossmatching on dock, Rack and N1/T1 main unit to locate the fault.
Power Board Comm Error	High	Cannot be cleared	Restart the monitor. If the alarm persists, replace the power board or the main control board.
Battery Error	High	Cannot be cleared	Reinstall the battery first. If the alarm persists, replace the battery. If the alarm still persists, replace the power board or the main control board.
RT Clock Need Reset	High	Cannot be cleared	Rest the time, and restart the monitor. If the alarm persists, replace the button battery of the main control board. If the alarm still persists, replace the main control board.
CMS/eGW Disconnected	Low	Audible and visual display can be cleared	The monitor is disconnected from the CMS. Check the network connection.
Fail To Get WLAN IP Address	Low	Cannot be cleared	Unable to automatically obtain the wireless network IP address. Check the network settings.
Fail To Get LAN1 IP Address	Low	Cannot be cleared	Unable to automatically obtain the wired network LAN1 IP address. Check the network settings.
Loading Default Config Failed	Low	Can be cleared	The default configuration is not correctly loaded. The monitor will restore to the factory default configuration for the current patient category.
The patient data	Med	Audible and visual display	Delete unnecessary earlier

Message	Severity	Alarm Clearing	Causes and Countermeasures
storage space is nearly full. Please delete some discharged patients.		can be cleared	discharged patient.

5.6 Troubleshooting Guide

5.6.1 Power On/Off Failures

Failure Symptom	Possible Cause	Countermeasure
Power on failure	AC mains not connected or insufficient battery power or battery damaged	■ Verify the AC mains is properly connected. ■ Verify the battery capacity is sufficient and the batter is not damaged.
	Cable defective or improperly connected	■ Verify the cable connecting the power-on/off button board to the main control board. ■ Verify the connecting cable connectors and corresponding sockets are not damaged.
	Power switch and indicator board damaged	Replace the power switch and indicator board.
	Power module defective	Replace the power module.
	Main control board failure	Replace the main control board.
	Power supply protection	■ If the main unit connects to other devices such as the module, external module rack, mouse, keyboard, USB disk, and scanning gun, first disconnect these devices from the main unit. If the monitor can be started after the disconnection, an external device may fail, leading to power supply protection. ■ If the main unit is not connected to other devices, check whether there is any short circuit fault in the internal module rack COM board or main control board and it leads to protection of the power output.

5.6.2 Display Failures

Failure Description	Possible Cause	Troubleshooting
The display screen does not function or the display is abnormal, but the main unit can operate	Cable defective or improperly connected	■ Verify the cables (screen cable and backlight cable) connecting the display screen to the main control board are correctly connected. ■ Verify the connecting cable connectors and corresponding sockets are not damaged.

Failure Description	Possible Cause	Troubleshooting
	LCD screen defective	Replace the front case assembly.
	Main control board software abnormal	Upgrade the software of the main control board.
	Backlight driver defective	Replace the main control board.
	Display driver defective	Replace the main control board.
The touch screen does not respond	Cable defective or improperly connected	■ Verify the cable connecting the touch screen to the main control board is properly connected. ■ Verify the connecting cable connectors and corresponding sockets are not damaged.
	Touch screen defective	Replace the front case assembly.
	Main control board software abnormal	Upgrade the software of the main control board.
	Main control board failure	Replace the main control board.
	Touch controller's firmware is running wrong.	Touch the screen stably for 20 seconds, if the touch screen still does not work, please restart the monitor. If the touch screen could not work yet, replace the front case assembly

5.6.3 Module Rack Failures

Failure Description	Possible Cause	Troubleshooting
SMR		
SMR cannot identify parameter modules	External cable defective or poorly connected	■ The cable connecting SMR and the main unit of the monitor is not connected properly or already damaged. Verify the connecting cables and connectors are not damaged. ■ Verify that contact screws on SMR or module are tightly fastened and well connected.
	Defective parameter module	Replace the malfunctioning parameter module with a known good module. If the patient monitor identifies the replacement module and can start measurement, it indicates that the original module is faulty.
	Wrong communication board software version	Upgrade the module and/or the SMR software to a compatible level.
	SMR power supply abnormal	■ Check whether the SMR interface output voltage of the main unit is 12 V. If it is abnormal, the internal module rack COM board or main control board fails. ■ Check whether the contact screw output voltage of the external module rack is 12 V. If it is abnormal, the communication module on the SMR fails.

	8-slot Module rack communication board defective	Replace 8-slot the module rack communication board.
	Internal cable defective or poorly connected	■ Verify the cable between the module rack interface board and the communication board is properly connected. ■ Verify the connecting cables and connectors are not damaged.
	Internal module rack COM board defective	Replace the internal module rack COM board.
	Logic version error of the internal module rack COM board	Upgrade the logic version of the internal module rack COM board.
	Main control board failure	Replace the main control board.
Internal module rack		
The parameter module does not respond	Defective parameter module	Replace the malfunctioning parameter module with a known good module. If the patient monitor identifies the replacement module and can start measurement, it indicates that the original module is faulty.
	Cable defective from the main control board to the internal module rack COM board	■ Verify the cable connecting the internal module rack COM board to the main control board is connected reliably. ■ Verify the connecting cables and connectors are not damaged.
	Version inconsistency between the module communication board and the internal module rack COM board	Upgrade the module or internal module rack COM board software.
	Power supply to the internal module rack is not correct	The internal module rack COM board or main control board may fail, and 12 V cannot be output.
	Main control board failure	Replace the main control board.

5.6.4 Alarm Failures

Failure Description	Possible Cause	Troubleshooting
Alarm LED off or cannot be turned off while the audible alarm is sounding	Cable defective or improperly connected	■ Verify the cable connecting the alarm LED board to the main control board is properly connected. ■ Verify the connecting cables and connectors are not damaged.
	Alarm LED board failure	Replace the alarm LED board.
	Main control board failure	Replace the main control board.
No audible alarm sounds emitted while	Audible alarm disabled	Check whether the audible alarm is muted. Select **Main Menu** →**System** >>→**Maintenance** >>→enter the required

Failure Description	Possible Cause	Troubleshooting
the alarm LED is normal		maintenance password→**Alarm>>**, and then in the popup menu, set **Minimum Alarm Volume** to a proper value. Select **Alarm→Setup**, and set the alarm volume to a proper value.
	Speaker failure	Replace the speaker.
	Cable defective or improperly connected	Verify the cable connecting the speaker to the main control board is properly connected.
	Main control board failure	Replace the main control board.

5.6.5 Recorder Failures

Failure Description	Possible Cause	Troubleshooting
No printout	Recorder module disabled	Verify the recorder status LED is lit. If it is lit, recover its function in "Factory Maintenance".
	Printing paper jam	Reinstall the paper roll properly.
	Cable defective or improperly connected	■ Verify the cable connecting the recorder and the main control board is properly connected. ■ Verify the connecting cables and connectors are not damaged.
	Recorder failure	Replace the recorder.
	Main control board failure	Replace the main control board.
Poor printing effect	Printing paper thermal coating failure	Replace the printing paper.
	Thermal head dirty	Clean the thermal head.
	Recorder failure	Replace the recorder.

5.6.6 Output Interface Failures

Failure Description	Possible Cause	Troubleshooting
No output for the nurse call signal	Internal module rack COM board defective	Replace the internal module rack COM board.
	Main control board defective	Replace the main control board.
	Cable defective or improperly connected	■ Verify the cable connecting the main control board to the internal module rack COM board is connected reliably. ■ Verify the connecting cables and connectors are not damaged.
	Logic exception of the internal module rack COM board	Upgrade the logic of the internal module rack COM board.
USB Device Unusable.	Main control board failure	Replace the main control board.

Failure Description	Possible Cause	Troubleshooting
Network interface failure	Main control board failure	Replace the main control board.
DVI interface failure	Display not matched with the DVI interface time sequence	Use the recommended display.
	Main control board defective	Replace the main control board.
Touch screen failure of the external display	External display model not specified in the manual	Use the display model recommended in the user manual.
	Touch pad damage of the external display	Replace the display.
	Touch pad firmware of the external display inconsistent with the system software	Contact the display manufacturer to fix the problem.

5.6.7 Power Supply Failures

Failure Description	Possible Cause	Troubleshooting
Battery cannot supply power	Battery damaged	Replace the battery.
	Cable defective or improperly connected	■ Verify the cable connecting the main control board to the battery interface board is correctly connected. ■ Verify the connecting cables and connectors are not damaged.
Battery cannot be recharged or cannot be fully recharged	Battery damaged	Battery change
	Cable defective or improperly connected	■ Verify the cable connecting the main control board to the battery interface board is correctly connected. ■ Verify the connecting cables and connectors are not damaged.
	Main control board failure	Replace the main control board.

5.6.8 Network Related Problems

Failure Description	Possible Cause	Troubleshooting
The patient monitor cannot be connected to iView system	No connection to the LAN	Verify the network cables and connectors are intact, the network interface connection is reliable, and the hub or switch setting is correct.

Failure Description	Possible Cause	Troubleshooting
	iView assembly failure	Start the monitor. The "beep" sound should be heard during startup. After the iView assembly starts, the iView interface can be displayed in the main unit. If neither of the above two conditions cannot be reached, check whether the power supply for the iView assembly is normal. If it is not normal, the main control board may be damaged; if the power supply is normal, the iView assembly is damaged.
Frequent dropouts	Improper network cable connection	Check for network cable connection and length (which should not exceed 50 m), or check whether the laid network cable is too near to the power supply for large power equipment.
	Incorrect network settings	Check for IP conflict in the network. If conflict is found, reset the network.
The patient monitor is connected to a network but cannot view other patients in the View Others mode	Improper network cable connection	Check for network cable connection and length (which should not exceed 50 m), or check whether the laid network cable is too near to the power supply for large power equipment.
	Too many simultaneous requests for viewing the patient monitor	Confirm the maximum number of simultaneously connected monitors according to the user manual.
	Incorrect network settings	Check for IP conflict in the network. If conflict is found, reset the network.
Failure to connect to a wireless network	Incorrect network settings	Verify the wireless network settings are correct.
	Antenna not installed properly	Verify the antenna for the wireless network card is connected to the wireless module reliably.
	Wireless module damaged	Replace the wireless module.
	Main control board failure	Replace the main control board.
MPAN failure	Antenna not installed properly	Verify the antenna for the MPAN module is installed properly.
	MPAN module damaged	Replace the MPAN module.
	MPAN module not connected to the internal module rack COM board properly	■ Verify the cable connecting the MPAN module to the internal module rack COM board is connected properly. ■ Verify the connecting cables and connectors are not damaged.
	Internal module rack COM board defective	Replace the module rack COM board.
	Wrong software version for the MPAN module	Upgrade the MPAN module software.

5.6.9 Software Upgrade Problems

Failure Description	Possible Cause	Troubleshooting
Program upgrade fails	Incorrect connection	■ Verify the network connector, NOT the iView network connector, on the patient monitor is being used. ■ Ensure the normal operation of the network hub or switch, and verify the hub cable is properly connected.
	Wrong upgrade package	Please select the corresponding correct wrong upgrade package.
	Incorrect IP address configuration for the PC	Configure a fixed IP address in range C as specified for the patient monitor. We recommend not to upgrade a program when the patient monitor is connected to a network with multiple PCs.

5.6.10 Device Integration Failures

Failure Description	Possible Cause	Troubleshooting
The "Devices Integrated" window displays nothing after connection	The ID adapter is not compatible with the external device	■ Replace the ID adapter. ■ Upgrade the ID of the ID adapter in "Factory Maintenance" menu.
	The serial port adapter cable not compatible with the external device	Replace the serial port adapter cable.
	Wrong software version or wrong protocol version of the external device	Verify the protocol version and software version are supported by the ID adapter.
Generate the alarm: "BeneLink Comm Stop"	The BeneLink module application software is corrupted	Upgrade or update the software application of the BeneLink module with the network upgrading tool.
The patient monitor has no response when loading the ID adapter	The BeneLink module application software is corrupted	Upgrade or update the software application of the BeneLink module with the network upgrading tool.
	BeneLink module damaged	Replace the module.

6 Upgrade

6.1 Overview

This monitor supports upgrade of the monitoring parameter function modules, upgrade of the functional assemblies, and network upgrade of software.

NOTE

- **For function upgrade involving disassembly of the monitor, eliminate static electricity before the disassembly. When removing some parts with the electrostatic sensitive mark, wear protective devices such as electrostatic ring or anti-electrostatic gloves, lest the parts would be damaged.**
- **Properly connect and route the cables and wires when reassembling the equipment to avoid pinched hoses and electrical short circuits.**
- **Use specified screws to reassemble the equipment. If the incorrect screws are forcefully tightened, the equipment may be damaged and the screws or part may fall off during use, causing unpredictable equipment damage or human injury.**
- **Be sure to follow the correct sequence when disassembling the monitor.**
- **Before removing assemblies, make sure that all the connection lines have been unplugged. During removal, note to avoid breaking the connection line by pulling or damaging the connector.**
- **Place the removed screws and other parts separately by category so that they can be used in the re-installation. Do not drop, contaminate or lose them.**

6.2 Upgrade of Parameter Function Modules

You can upgrade the following parameter modules:

Monitoring Parameter Module	PN	Name and Specification	Remarks
MPM module	115-038696-00	MPM-1 Module (MR Spo_2/3/5 lead/IBP)	
	115-038697-00	MPM-3 Module (NC Spo_2/3/5 lead/IBP)	
	115-044666-00	MPM-7 Module (MR Spo_2/3/5lead/No IBP)	
	115-044667-00	MPM-9 Module (NC Spo_2/3/5lead/No IBP)	
	115-038698-00	MPM-13 (MR SpO_2/12lead/IBP/Analog)	

6.2 Upgrade of Parameter Function Modules

You can upgrade the following parameter modules:

Monitoring Parameter Module	PN	Name and Specification	Remarks
MPM module	115-038696-00	MPM-1 Module (MR Spo_2/3/5 lead/IBP)	
	115-038697-00	MPM-3 Module (NC Spo_2/3/5 lead/IBP)	
	115-044666-00	MPM-7 Module (MR Spo_2/3/5lead/No IBP)	
	115-044667-00	MPM-9 Module (NC Spo_2/3/5lead/No IBP)	
	115-038698-00	MPM-13 (MR SpO_2/12lead/IBP/Analog)	
	115-038699-00	MPM-14 (NC SpO_2/12lead/IBP/Analog)	
	115-038700-00	MPM-13 (MR SpO_2/12lead/IBP/Analog)	
	115-038701-00	MPM-14 (NC SpO_2/12lead/IBP/Analog)	
IBP module	6800-30-50850	IBP Module (Package/no accessory)	
C.O. module	115-015238-00	CO Module kit (M03B V2.0) No accessory	
CO_2 module	115-013200-00	CAPNOSTAT CO_2 (Package/no accessory)	
	115-013201-00	ORIDION CO_2 (Package/no accessory)	
	115-034095-00	CO_2+O_2 Module (package/ Adu accessory)	
	115-037385-00	One-slot CO_2_O_2 module	
AG module	115-034108-00	AG Module (package/no accessory)	
	115-034109-00	AG Module (O_2/package/no accessory)	
	115-034110-00	AG Module (BIS/package/no accessory)	
	115-034111-00	AG Module (O_2/BIS/package/no accessory)	
ICG module	115-034123-00	ICG Module (package/ no accessory)	
BIS module	115-013194-00	BIS Module (Package/no accessory)	
RM module	115-034114-00	RM Module (package/no accessory)	
SPO_2 module	115-015015-00	SPO2 Module (MS-2013， No accessory)	
	115-034088-00	SPO2 Module NC (package/ no accessory)	
	115-015016-00	SPO_2 Module (9008 V2.0, No accessory)	
CCO/SvO_2 module	115-013196-00	CCO/SvO_2 Module (Package/no accessory)	
PiCCO module	115-013196-00	PiCCO Module (Package/no accessory)	
ScvO2 module	115-013199-00	SCVO2 Module (Package/no accessory)	
EEG module	115-018353-00	EEG Module (Package/without accessory)	
NMT module	115-020916-00	NMT Module (Package/no accessory)	
Benelink module	115-038771-00	Benelink Module International (Package)	
rSO_2 module	115-037264-00	rSO_2module	
TEMP module	115-039492-00	Temp module (package/no accessory)	
Infrared ear Temp module	115-044684-00	Infrared ear Temp (no accessory/package)	

You can insert and remove all the parameter modules during patient monitoring. Refer to the BeneVision N Series Patient Monitor Operator's Manual (P/N: 046-009995-00) for the use of parameter modules.

6.3 Upgrade of Functional Assemblies

NOTE

- **When upgrading the wireless network, analog output and CIS function for a patient monitor with standard configuration, you have to replace old PCBAs in the patient monitor with corresponding PCBAs included in the upgrade kit and remove the covers of related connectors in addition to installing the corresponding functional assemblies in the monitor.**

You can upgrade the following functional assemblies for this monitor: the satellite module rack (SMR), wireless network functional assembly, MPAN, recorder, independent display assembly, iView system functional assembly, etc.

Functional Assembly	PN	Name and Specification	Remarks
SMR	115-037384-00	SMR material package (2m/without handle and hook)	
	115-033887-00	SMR material package (2m/with handle and hook)	
	115-033888-00	SMR material package (10m/with handle and hook)	
Recorder	115-044523-00	Recorder upgrade package	
Wifi	115-04452	2.4G/5G Wifi upgrade package	
MPAN	115-044	MPAN upgrade package	
iView	115-044553-00	iView upgrade package (Without MainBoard)	
	115-044578-00	iView upgrade package (MainBoard)	
Independent Display	115-044554-00	ID upgrade package (Without MainBoard)	
	115-044579-00	ID upgrade package (MainBoard)	
N12 Upgrade package (DVI&TDS&BNC)	115-044508-00	Upgrade package (DVI&TDS&BNC)	

This monitor is configured with wireless network functions and can be connected to network through wireless AP. To upgrade wireless functions, ask authorized personnel of our company to connect and set up the wireless network, and then carry out the performance test.

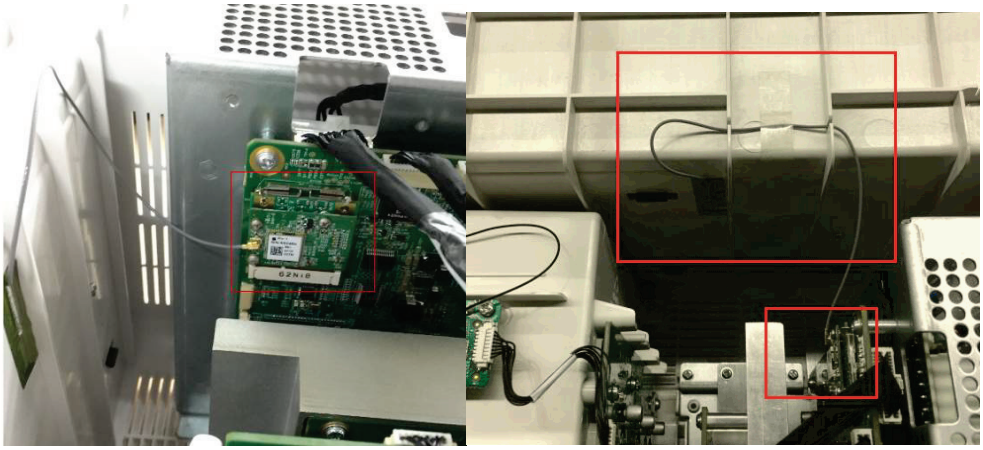
6.3.1 Upgrading SMR

The SMR can be connected to the patient monitor through the SMR connector via a powered USB cable.

For details, see BeneVision N Series Patient Monitor Operator's Manual (P/N: 046-009995-00).

6.3.2 Upgrading Wireless Network Functions

- Installation method: Refer to the corresponding section of this manual to install the wireless network functional assembly in your patient monitor. Pleases install the assembly as shown in the following pictures.
- How to use WiFi functions: See BeneVision N Series Patient Monitor Operator's Manual (P/N: 046-009995-00).



The wireless signal will be affected by inaccuracy installation location of the antenna.

6.3.3 Upgrading Recorder

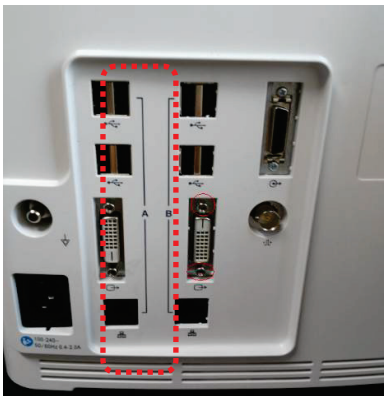
- Installation method: Refer to the corresponding section of this manual to install the recorder in your patient monitor.
- How to use the recorder: See BeneVision N Series Patient Monitor Operator's Manual (P/N: 046-009995-00).

6.3.4 Upgrading iView System

- Installation method: Refer to the corresponding section of this manual to install the related boards of the iView upgrade package in your patient monitor.
- How to use iView system functions: See BeneVision N Series Patient Monitor Operator's Manual (P/N: 046-009995-00).

NOTE

- **During installation, use a blade to cut off the seals for the USB, DVI and network interface at the rear case so that the interface can stretch out from the rear case.**

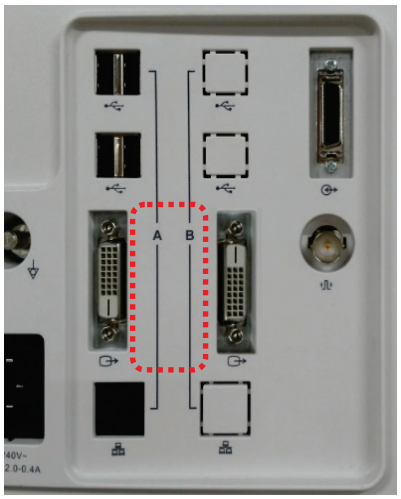


6.3.5 Upgrading Independent Display Function

- Installation method: Refer to the corresponding section of this manual to install the related boards of the independent display upgrade package in your patient monitor.
- How to use the independent display function: See BeneVision N Series Patient Monitor Operator's Manual (P/N: 046-009995-00).

NOTE

- **During installation, use a blade to cut off the DVI seal at the rear case so that the interface can stretch out from the rear case.**



6.4 Upgrading Software

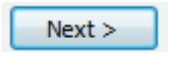
This monitor supports network upgrade through a PC or upgrade through a USB disk to complete the update function for the monitor and peripheral related firmware.

- You can upgrade the software with the System Update Tool (PN: 110-005042-00 PC Upgrade Tool) through network. This tool can directly run on a PC. Through network or by connecting the patient monitor to a PC via a crossover network cable, you can upgrade the following programs.
- The programs of this monitor can also be upgraded through a specially authorized USB disk (which contains the USB disk upgrade BIOS program PN:110-004854-00) or the following programs of the monitor can also be upgraded.

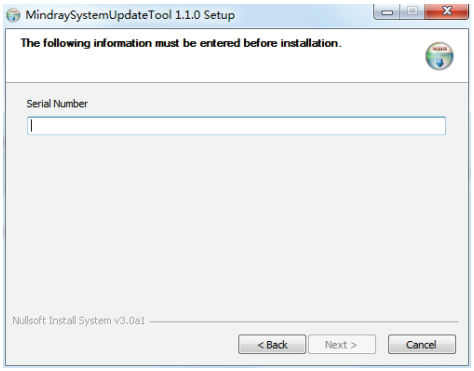
Software	PN	Name and Specification	Remarks
System software package	/	Large N12N15N17 system package	/
Module rack software	/	Bluetooth firmware function program	/
	/	FPGA write software	/
MPM modules	/	M51C module DSP(BF70X) software	/
	/	M51C module M0 software	/
	/	Mindray monitoring algorithm package (extended ARR 12-lead ST Glasgow12-lead resting)	ECG configuration software
	/	Mindray monitoring algorithm package (full function configuration) BF512	ECG configuration software
IBP module	/	M03B module write software	/
CO module	/	M03B module write software	/

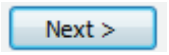
6.4.1 Description of Network Upgrade Tool

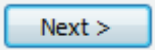
6.4.1.1 Tool Software Installation Method

1. Click the executive program "SystemUpdateTool.exe" of the system upgrade tool software to display the related prompt interface. Click 

to enter the input interface of the information about SN.



2. Enter the SN information, and click 

to enter program installation location interface. Select the corresponding folder for installation, and click 

to complete installation according to the installation prompt.

6.4.1.2 PC and Monitor Connection Method

Make sure that at least one network card is installed on the PC, and the PC is connected to the monitor through the network card.

1. PC connected to the monitor through the hub
   - ◆ PC connected to the hub through a network cable: Connect one end of the network cable to the network card slot of the PC and the other end to the hub slot.
   - ◆ Hub connected to the monitor through a network cable: The connection method is the same as the above method. The hub has multiple slots, so multiple (at least 5) monitors can be connected in this case and upgraded at the same time.
2. Changing the IP address of PC network card

NOTE

- **To ensure correct upgrade, the IP address set using the following rule must be used before running the upgrade program. The IP address must be set to 77.77.1.xx, but there are no special requirements for the gateway and DNS. For example, the IP address is 77.77.1.13, and the subnet mask is "255.255.255.0".**

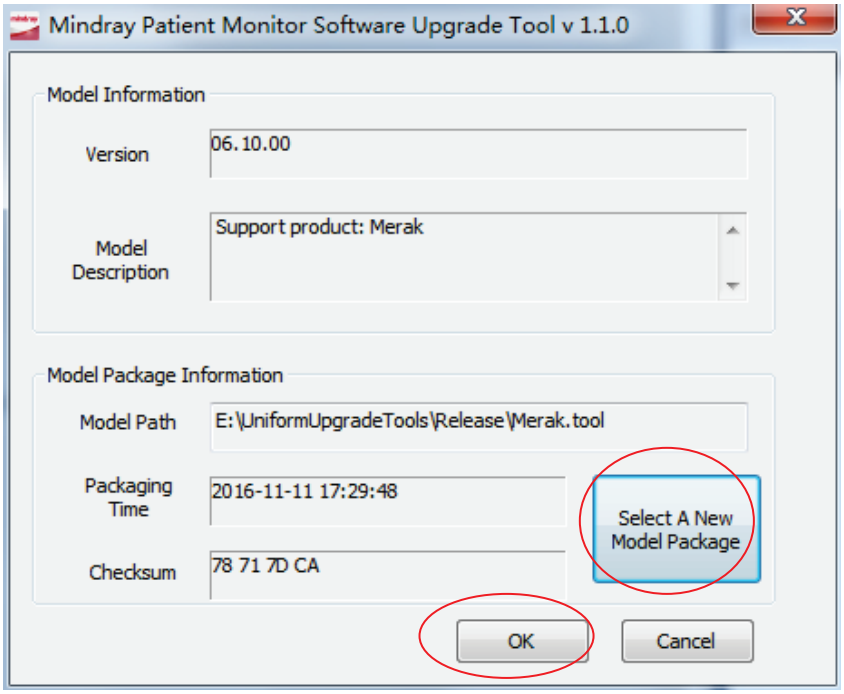
How to enter the upgrade mode:

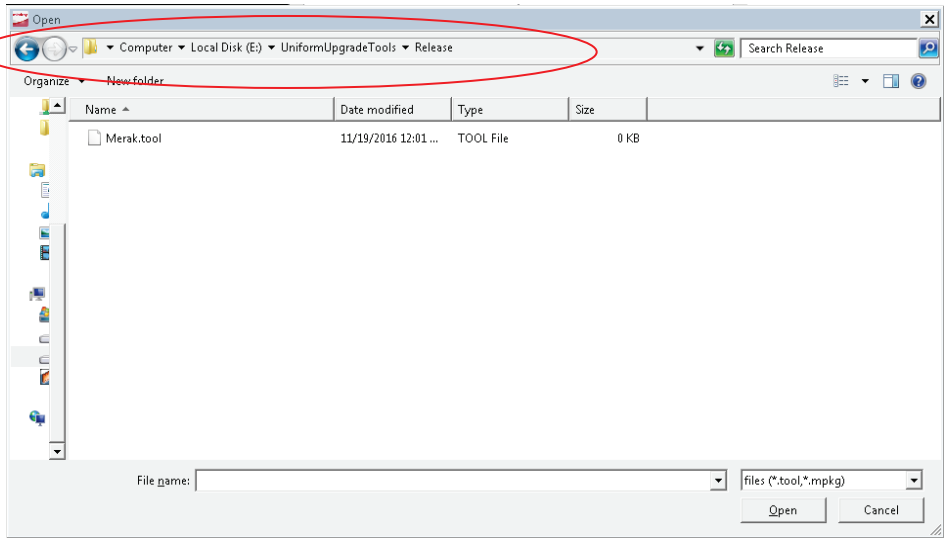
- ■ Connect the monitor to the USB keyboard. When starting the monitor, constantly click ' F4+F5' or '*' at the same time to enter the upgrade mode to perform upgrade;
- ■ When starting the monitor, use two or more fingers to continuously and rapidly tap the screen to enter the upgrade mode to perform upgrade.

6.4.1.3 Software Tool Upgrade Operations

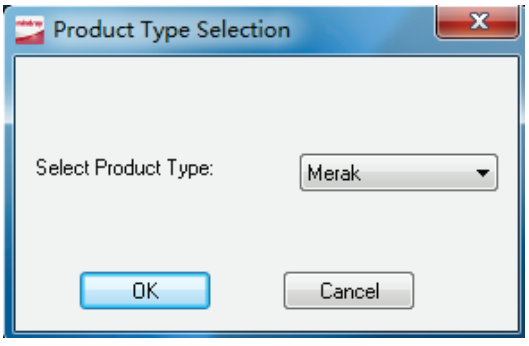
The software upgrade package of each product needs to be set according to the above configuration requirements. The software upgrade package can only be set by the administrator and is also specially managed by the administrator. System software upgrade settings:

1. Download the large software package of N12/M12/N15/M15/N17/M17 system (the storage location is the model package path), run the installed system (network) upgrade tool software, click Select A New Model Package, select the "Merak.Tool" model package, click Open, and then click OK, as shown in the following figures:

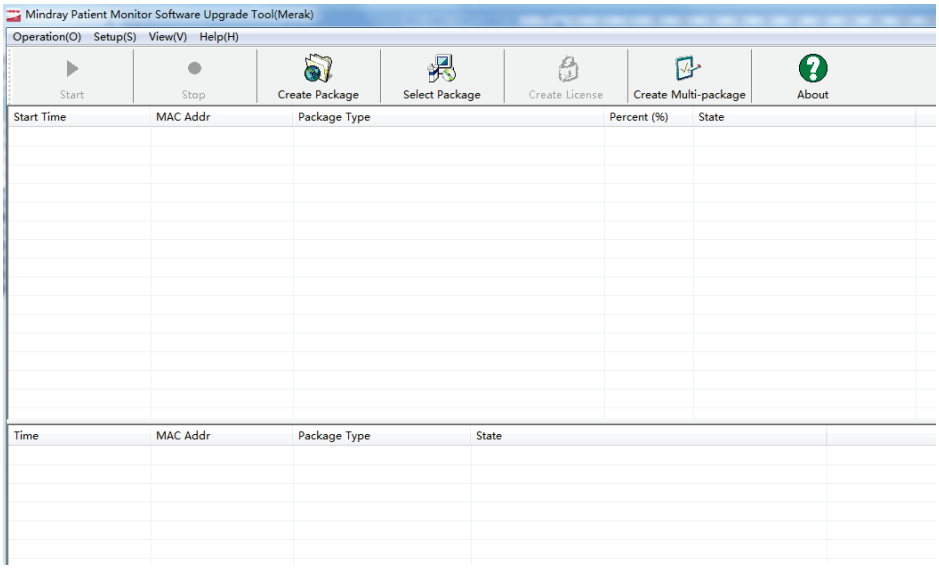




2. On the displayed machine type selection interface, select the machine type "Merak".



The following interface is displayed on the PC:



6.4.2 Guide to Software Upgrade Operations

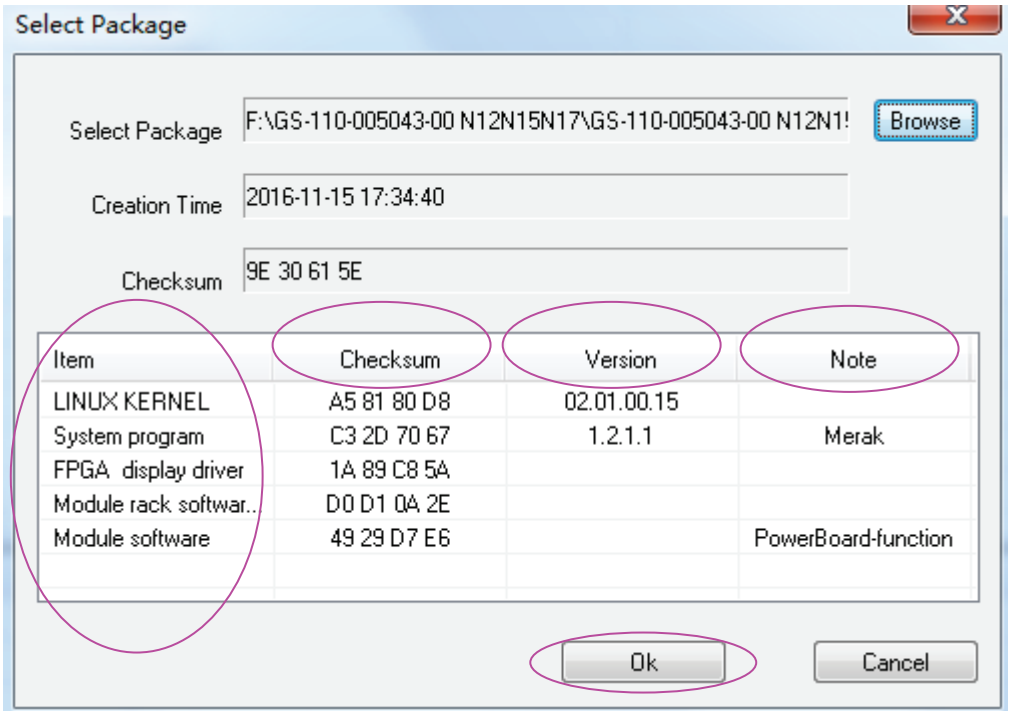
6.4.2.1 System Software Upgrading Method

1. Enter the main interface for downloading of system upgrade, and click 

.

   Select the prepared system software upgrade package file through browsing, check to ensure that the selected downloading content (including the information such as the upgrade item, check sum, version and description) is correct, and then click OK.

Now, the Start hot key of the main menu is enabled.

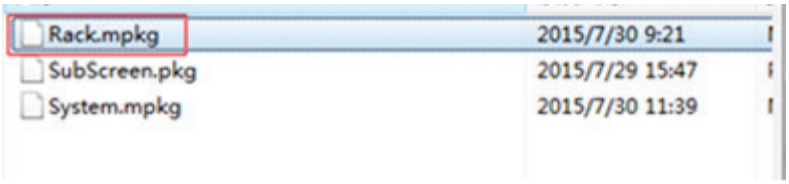


Confirm that the downloading network cable is connected correctly, make sure that the monitor has been powered off, and click the Start hot key of the upgrade tool to enter the downloading procedure of software.

6.4.2.2 Upgrading Module Rack Software

1. First connect the SMR connection line to the multi-function interface of N12/M12/N15/M15/N17/M17 main unit (the system software has been upgraded, and the main unit is off), connect the downloading network cable to the N12/M12/N15/M15/N17/M17 main unit (the same as the connecting method for upgrade of the N12/M12/N15/M15/N17/M15 main unit), and confirm that all the connection lines are connected correctly.
2. Enter the main interface for downloading of system upgrade, click " 

", and select the Rack.pkg file in the large software package of N12/M12/N15/M15/N17/M17 system:



3. Upgrade the SMR upgrade program by referring to “System Software Upgrading Method”.
4. If the upgrade fails, check whether all the wires are connected correctly, and then perform upgrade again.

6.4.2.3 Upgrading Module Software

Upgrade the module program file by referring to “System Software Upgrading Method”. When the upgrade is completed, click the Stop button on the upgrade menu to stop the upgrade, remove the network cable, turn off the monitor, and then restart it.

For the detailed operations of network program upgrade, refer to the help and instructions included in the System Update Tool, or consult your service personnel.

6.4.3 Guide to Upgrade through a USB Disk

6.4.3.1 Directory Structure Preparation for Upgrade through a USB Disk

Required tools:

- USB disk: a common USB disk in the FAT format (e.g., the USB disk of Kingston, Netac or other models with at least 2GB memory).

1. Create the following content under the root directory of the USB disk: UPGRADE_AMP\Merak.
2. Copy the upgrade BIOS program Merak_Installer.pkg (do not change this file name) to the UPGRADE_AMP\Merak directory.
3. Copy the upgrade file (PKG or MPKG) to the UPGRADE_AMP\Merak directory.

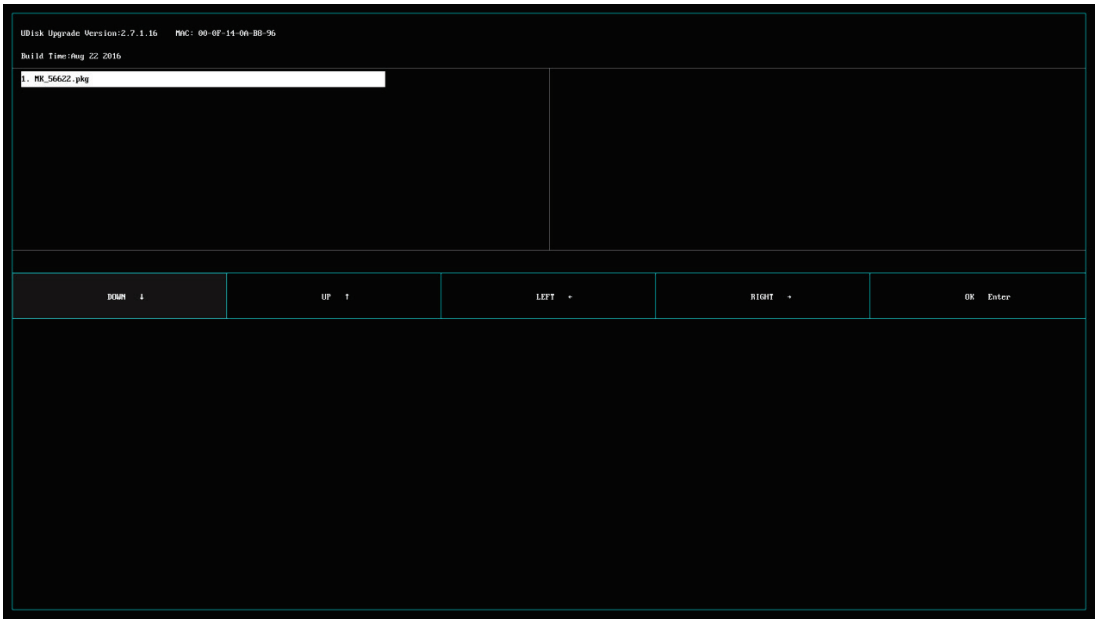
6.4.3.2 Inserting the USB Disk into the USB port of the Monitor

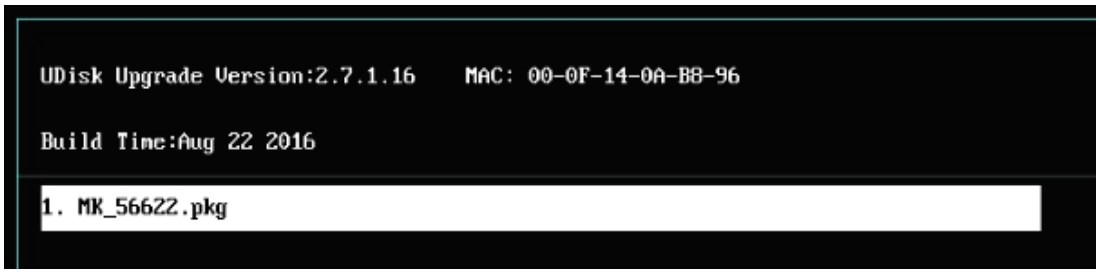
Insert the prepared USB disk into anyone of the four (4) USB ports of the main control board. Do not insert the USB disk into the USB port of the iView board.

6.4.3.3 Entering Upgrade through the USB Disk

- Method 1: As pressing the on/off button of the monitor to start the monitor, use two or more fingers to continuously and rapidly tap the touch screen to enter the upgrade mode.
- Method 2: Connect the USB keyboard, and constantly click 'F2+F3' or 'F4+F5' or '*' at the same time to power on the monitor and enable it to enter the upgrade mode; in this way, the user's upgrade file selection interface can be accessed.

6.4.3.4 Selecting the File for Upgrade through the USB Disk



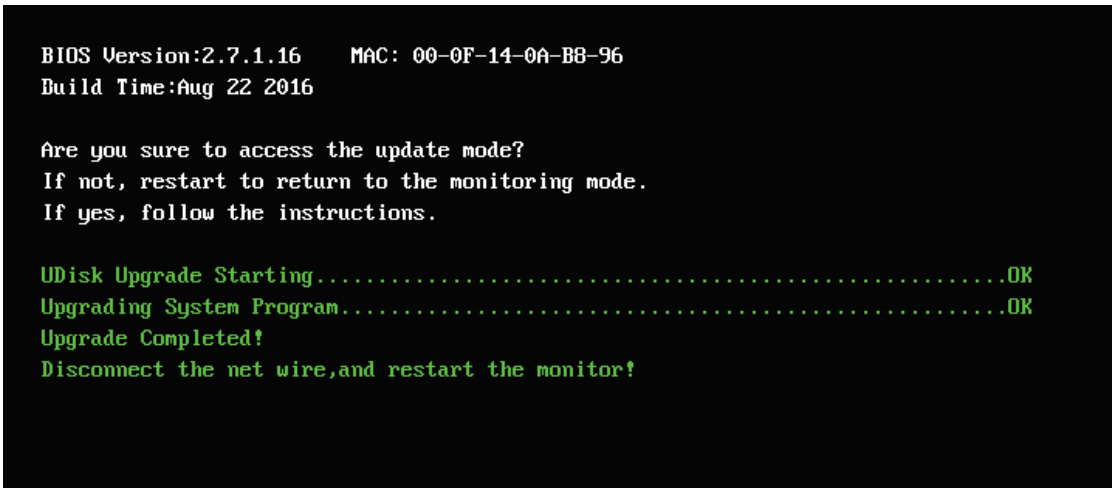


- Only one upgrade package file is available at present. It is selected by default. If multiple upgrade packages exist, they are displayed in the left and right columns, and a maximum of 16 upgrade packages can be displayed. This upper limit cannot be exceeded. The up, down, left and right keys can be used to switch and select the desired upgrade package.
- Tap the DOWN ↓ area on the touch screen to select the upgrade program downward; or press the "↓" direction key on the keyboard to select it;
- Tap the UP ↑ area on the touch screen to select the upgrade program upward; or press the "↑" direction key on the keyboard to select it;

- Tap the LEFT ← area on the touch screen to select the upgrade program leftward; or press the "←" direction key on the keyboard to select it;
- Tap the RIGHT → area on the touch screen to select the upgrade program rghtward; or press the "→" direction key on the keyboard to select it;
- Tap the OK Enter area on the touch screen to confirm the selected upgrade program; or press the Enter key on the keyboard to confirm it.

6.4.3.5 Upgrade Completed through the USB Disk

When the interface below is displayed, the current upgrade is completed. The upgrade takes effect after the monitor is powered off and restarted.



⚠CAUTION

- **Disconnect the patient monitor from the patient and make sure that important data are saved before upgrade.**
- **Do not shut down or power off the equipment when upgrading the BIOS program and FPGA program. Otherwise, the equipment may break down.**
- **Program upgrade should be performed by qualified service personnel only. Indicates a potential hazard or unsafe practice that, if not avoided, could result in minor personal injury or product/property damage.**

NOTE

- **After upgrading the BIOS program, you have to upgrade system program and other programs to ensure their compatibility.**
- **Make sure the version of the upgrade package is your desired one. If you want to obtain the latest upgrade package, contact Mindray Customer Service Department.**

6.5 Upgrading CAA license function

To upgrade the monitor to have CAA functions, you need to buy the licenses. Provide the following information when you order the licenses:

- Order number (contents CAA license function requirement)
- Product Model (for example, BeneVision N17/M17)
- Monitor serial number (for example, F2-6C000031)
- MID number/MAC address (for example: 000F140839AE). To get the MID number, select : Main Menu → License (in the System column).
- Customer's email (for receiving license key file)

Refer to the following instructions to upgrade the licenses

1. Unzip the PMLS.zip file. Then you would get a folder named PMLS.
2. Copy the folder to a USB disk.
3. Plug the USB disk into the BeneVision N series patient monitor.
4. In the interface of BeneVision monitor, choose **Main Menu→License** (in the System column)→**External**, and then click the Install button.

NOTE

- **The U disk should be FAT32 format.**
- **The PMLS folder should be in the root directory.**
- **On the root folder should be the PMLS folder and inside the PMLS folder should be the folder named same as MID number, and in there should be the license files.**

FOR YOUR NOTES

7 Repair and Disassembly

7.1 Tools

During disassembly and repair, the following tools may be required:

- Phillips screwdrivers
- Small flat-bladed screwdriver (specification 101 or 102)
- Tweezers
- Needle nose pliers
- M3 sleeve

7.2 Preparations for Disassembly

Before disassembling the monitor, make following preparations:

- Stop monitoring the patient, turn off the monitor and disconnect all the accessories and peripheral devices.
- Disconnect the AC power supply and take out all the batteries.
- Remove all the parameter modules in the integral module rack;
- if the SMR is connected, disconnect the SMR from the monitor and then remove all the parameter modules in it.

⚠CAUTION

- **Eliminate static electricity before the disassembly. When removing some parts with the electrostatic sensitive mark, wear protective devices such as electrostatic ring or anti-electrostatic gloves, lest the parts would be damaged.**
- **Properly connect and route the cables and wires when reassembling the equipment to avoid pinched hoses and electrical short circuits.**
- **Use specified screws to reassemble the equipment. If the incorrect screws are forcefully tightened, the equipment may be damaged and the screws or part may fall off during use, causing unpredictable equipment damage or human injury.**
- **Be sure to follow the correct sequence when disassembling the monitor.**
- **Before removing assemblies, make sure that all the connection lines have been unplugged. During removal, note to avoid breaking the connection line by pulling or damaging the connector.**

⚠CAUTION

- **Place the removed screws and other parts separately by category so that they can be used in the re-installation. Do not drop, contaminate or lose them.**

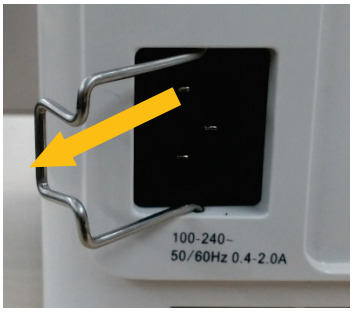
7.3 Whole Unit Disassembly

7.3.1 Basic Disassembly

NOTE

- **Be sure to disassemble the base first before proceeding with other parts.**

1. Remove the power plug anti-pull hook from the rear case of the monitor.



2. Use a tweezer to pry up the four screw covers at the four corners of the rear case and loosen and remove the four M3×8 screws under them.

(Screw cover)

(Screw)

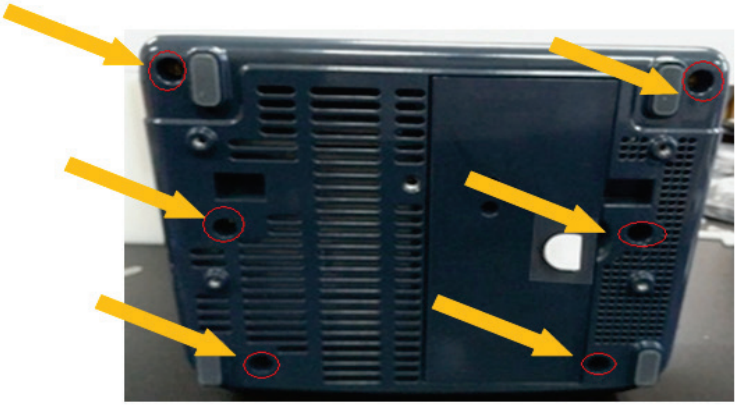
7.3.2 Disconnecting the Base

NOTE

- **Be sure to place the monitor face up when disconnecting the base. To lay the monitor face down, make sure that the surface is non-abrasive and static-free, lest the touch screen would be scratched. Be sure to remove the base first before proceeding with other parts.**

1. As shown in the figure below, place the monitor face up, unscrew the M4×8 screws (5 for the N12/M12 series and 6 for the N15/M15/N17/M17 series) from the bottom case;

(N12)

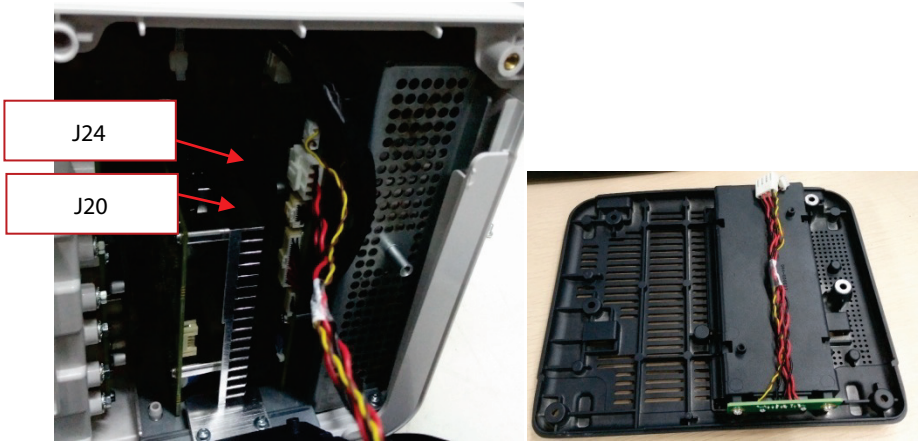


(N15/N17)

2. Pull out the base.

   ◆ For the N12/M12 series machines, the base assembly can be removed when the base is pulled out.

   ◆ For the N15/M15/N17/M17 series machines, the base assembly can be removed when the connection line connected to the battery interface board of main board is pulled out.



NOTE

- **Be sure to pull out the base with proper force, without damaging the cables and connectors.**

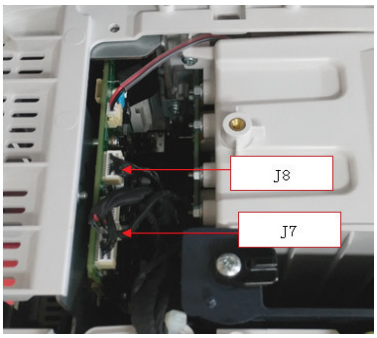
7.3.3 Separating the Front and Rear Half of the Monitor

1. After the base assembly is removed, carefully place the monitor face down.

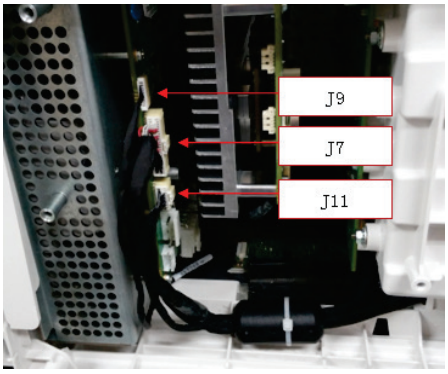
NOTE

- **Before placing the monitor face down, make sure that the desktop is flat, without foreign matters, lest the screen would be damaged.**
- **Release the clip (if any) on the connection line socket before disconnecting the connection line. Be sure to pull out the base with proper force, without damaging the cables and connectors.**

◆ For the N12/M12 series machines, remove the connection line for the LCD screen and the connection line for the small board of front case.



◆ For the N15/M15/N17/M17 series machines, remove the connection line for the touch screen, connection line for the LCD screen and the connection line for the small board of front case.

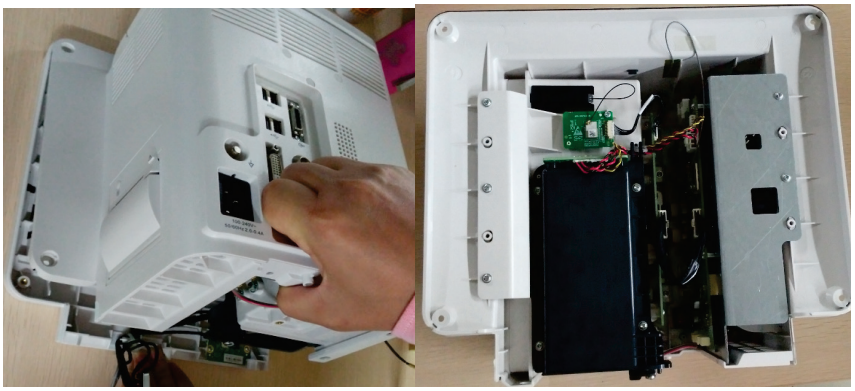


2. Lift the rear case assembly to separate it from the front case assembly.

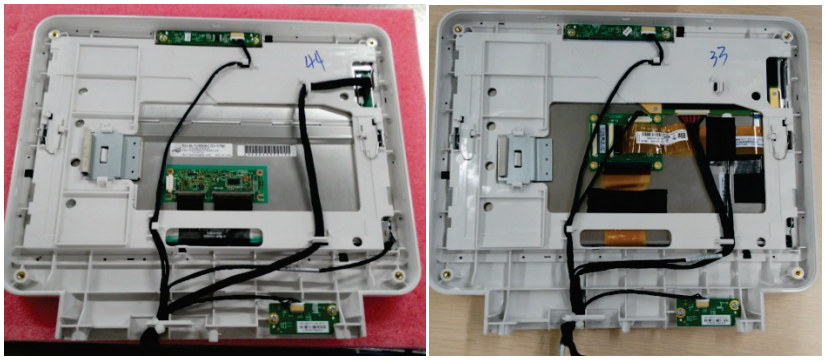
NOTE

- **As shown in the above figure, there are two types of front case assemblies (NLT and SHARP), which are different in the cabling way.**

◆ N12/M12



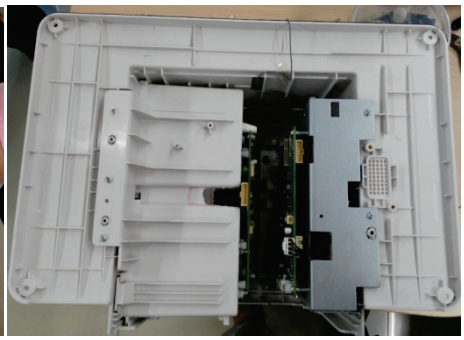
(N12/M12 rear case assembly)



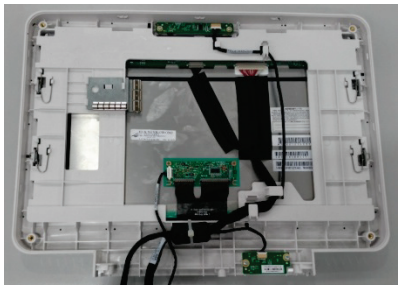
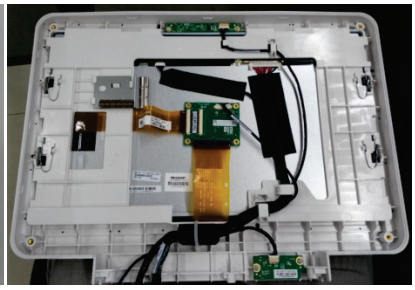
(N12/M12-NLT front case assembly)

(N12/M12-SHARP front case assembly)

◆ N15/M15

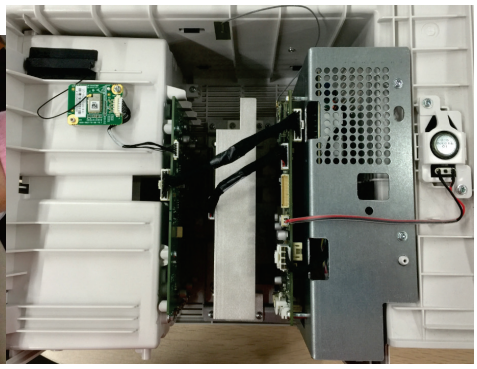



(N15/M15 rear case assembly)

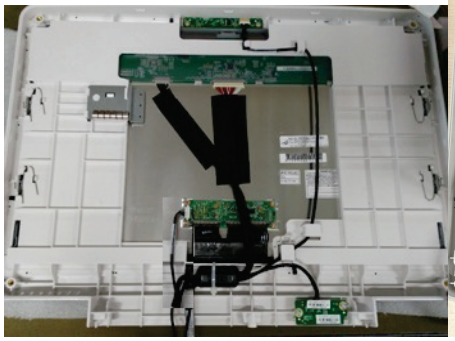
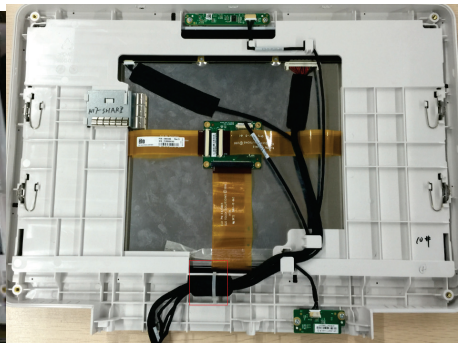



(N15/M15-NLT front case assembly) (N15/M15-SHARP front case assembly)

◆ N17/M17

(N17/M17 rear case assembly)

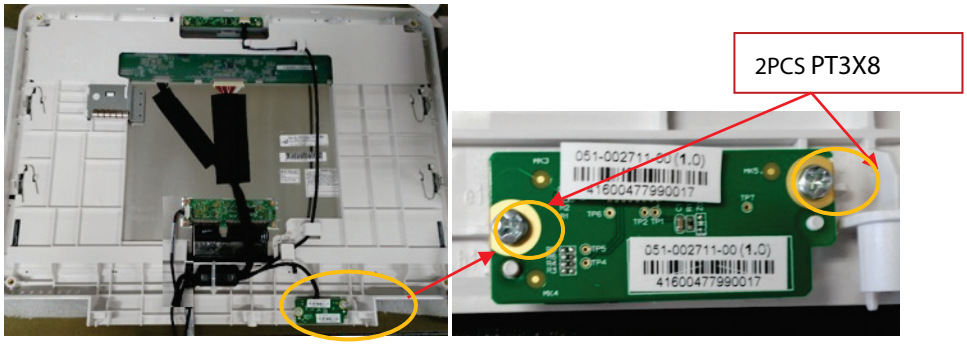



(N17/M17-NLT front case assembly) (N17/M17-SHARP front case assembly)

7.4 Further Disassembly of the Front Case Assembly

7.4.1 Removing the PowerSwitch Board

1. Remove the connection line on the powerswitch board.
2. Remove the two PT3×8 screws and take out the powerswitch board.

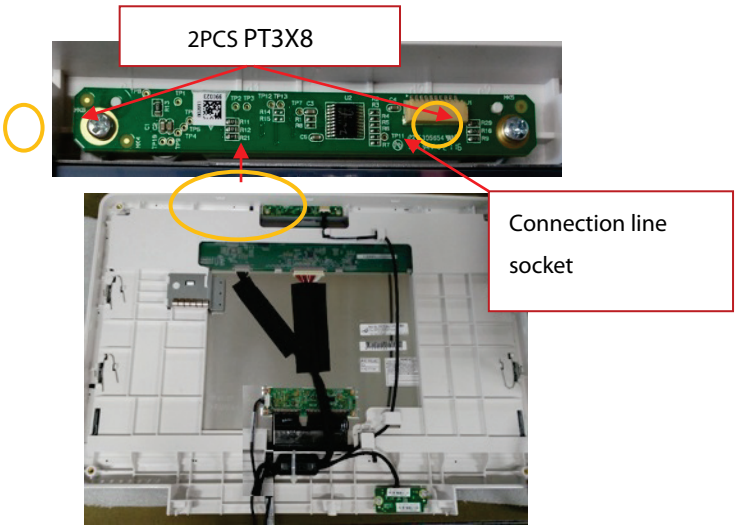


NOTE

- **Use proper force to remove the cable carefully lest it would be broken.**
- **During installation, press the board to the silicone keypad direction by aligning with the front case board positioning rib.**
- **Note to control the torsion when tightening the twoPT3×8 screws again, avoiding screw sliding.**

7.4.2 Removing the Alarm Lamp and Light Sensor Board

1. Remove the connection line on the alarm lamp and light sensor board.
2. Remove the two PT3×8 screws and take out the alarm lamp and light sensor board.

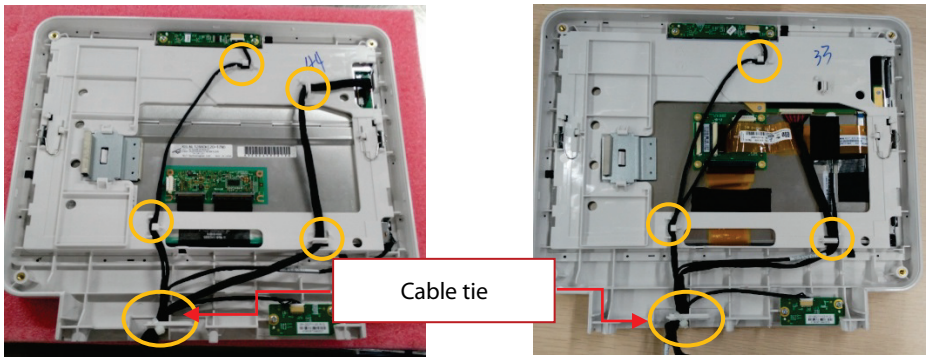


NOTE

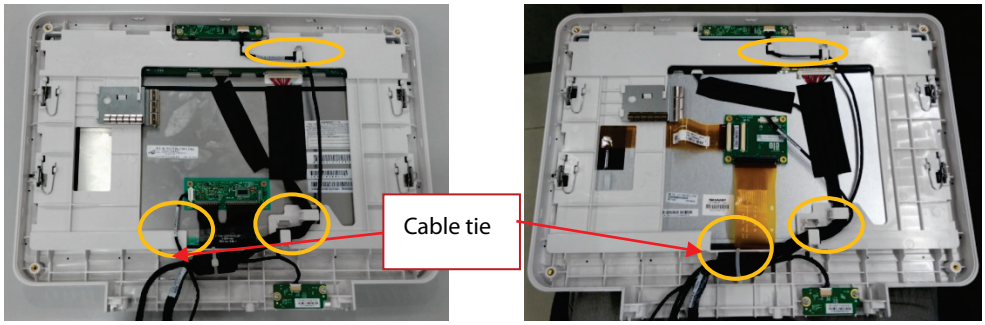
- **Use proper force to remove the cable carefully lest it would be broken.**
- **During installation, press the board to the alarm lamp shade direction by aligning with the front case board positioning rib.**
- **Note to control the torsion when tightening the two PT3×8 screws again, avoiding screw sliding.**

7.4.3 Removing the Screen Assembly Connection Line

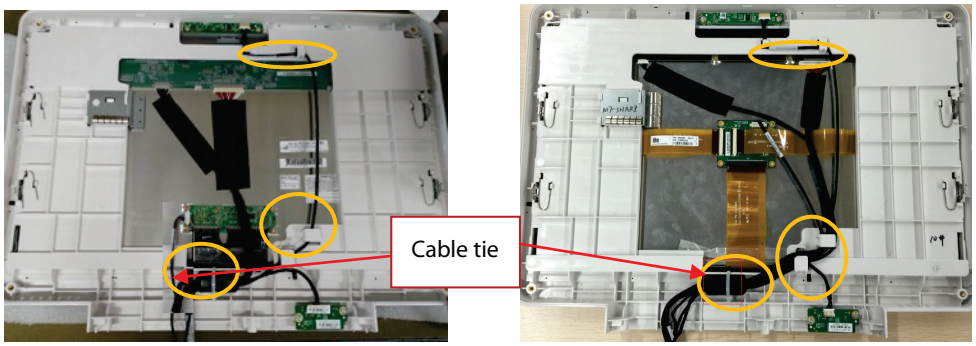
1. Cut off the cable time used to tie the connection lines, and remove the connection line connector connected to the display screen and touch screen control board. All the connection lines can be removed by releasing the buckling position for clamping cable on the front case.



(N12/M12-NLT) (N12/M12-SHARP)



(N15/M15-NLT) (N15/M15-SHARP)



(N17/M17-NLT) (N17/M17-SHARP)

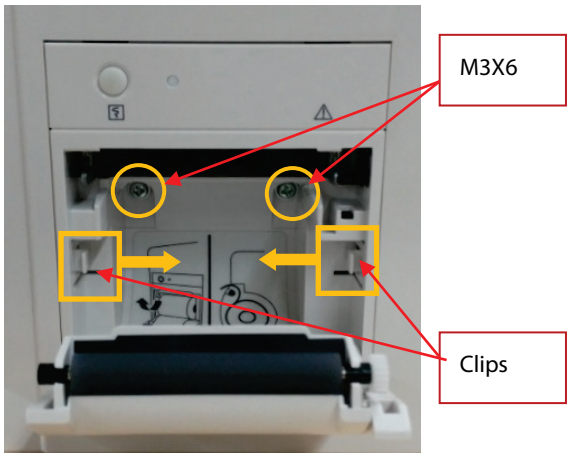
CAUTION

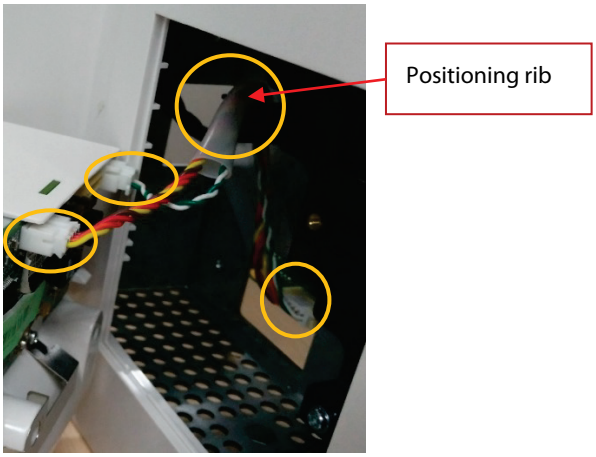
- **Prevent pressure on the front face of display screen during disassembly.**
- **Remove the LCD screen assembly in an environment as dust-free as possible; the display screen and touch screen are integrated materials and cannot be disassembled. Indicates a potential hazard or unsafe practice that, if not avoided, could result in minor personal injury or product/property damage.**

7.5 Further Disassembly of the Rear Case Assembly

7.5.1 Removing the Recorder

1. First open the recorder door on the right of the machine, and then unscrew the two M3×6 screws.
2. Pull the two clips in as indicated in the figure below to separate it from the rear case, and pull out the recorder at the same time.
3. After the recorder is pulled out, take down the recorder connection line from the positioning rib, and pull out the socket respectively. Then, the recorder can be removed.



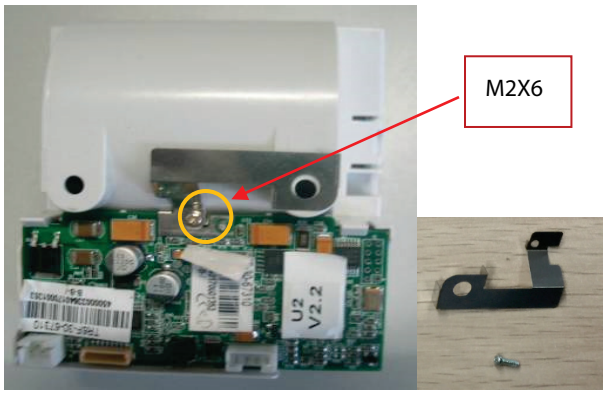


NOTE

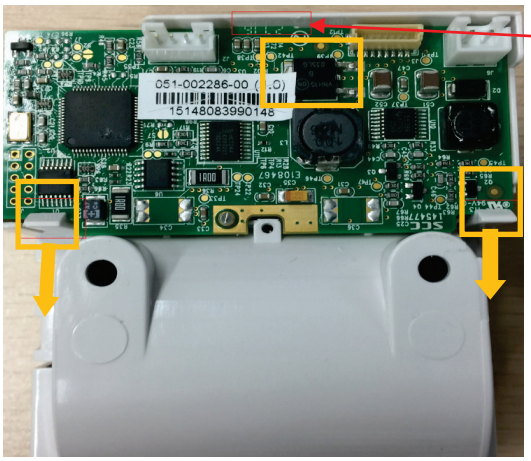
- **Use proper force to remove the cable carefully lest it would be broken.**

7.5.2 Further Disassembly of the Recorder

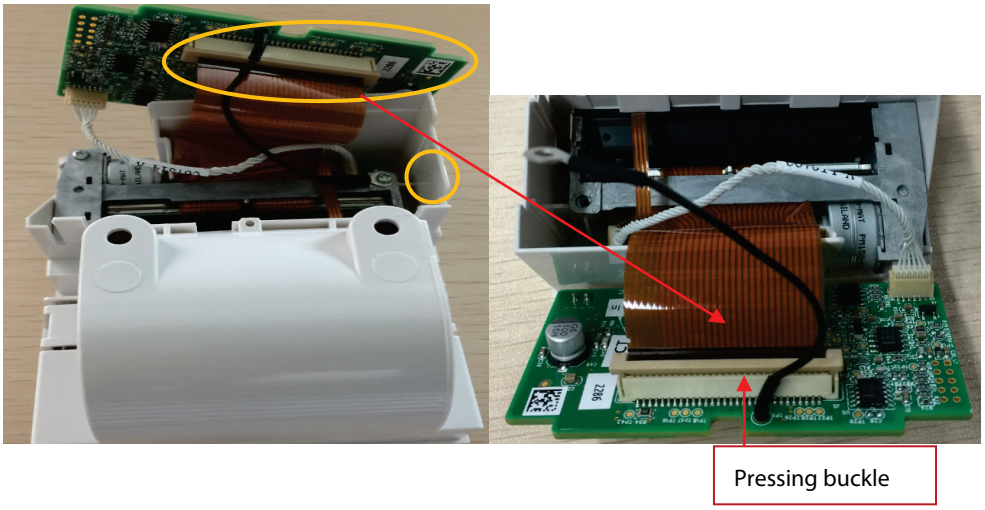
1. First remove one PT2X6 screw, and take down the grounding piece at the same time.



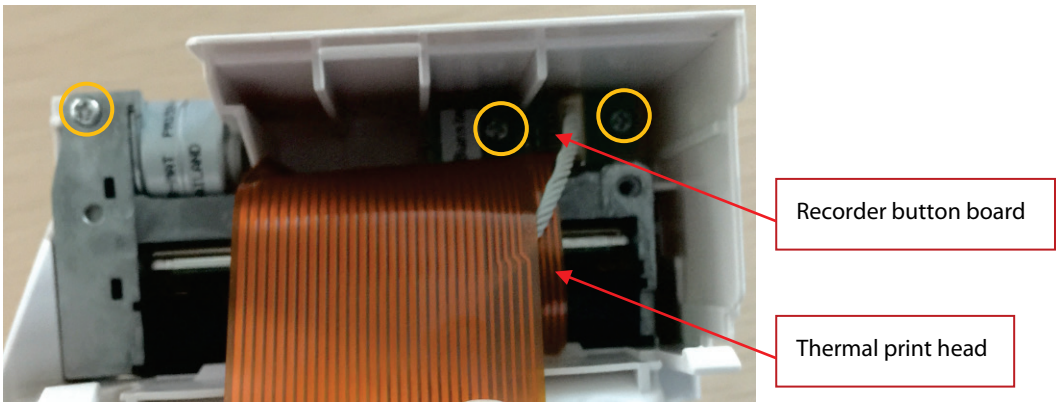
2. Release the two clips backward and take out the recorder drive board. Pay attention to the snap in the front.



3. First pull up the pressing buckle by about 1 mm to remove the flexible cable; remove the connection line from the drive board to the button board; unscrew one PT2×6 screw, and remove the ground cable of the drive board. Remove the recorder drive board.



4. Remove the other PT2×6 screw and take out the thermal printhead.
5. Loosen and remove the two PT2×6 screws and remove the button board of recorder.

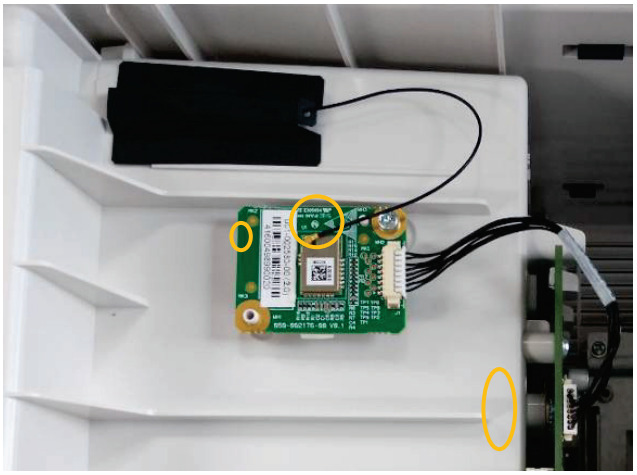


NOTE

- **Use proper force to remove the cable carefully lest it would be broken.**

7.5.3 Removing the MPAN Board

1. Pull out the MPAN board connection line at the end of internal module rackCOM board; then pull out the MPAN antenna connector inserted on the MPAN board; unscrew one M3×6 screw to remove the MPAN board.



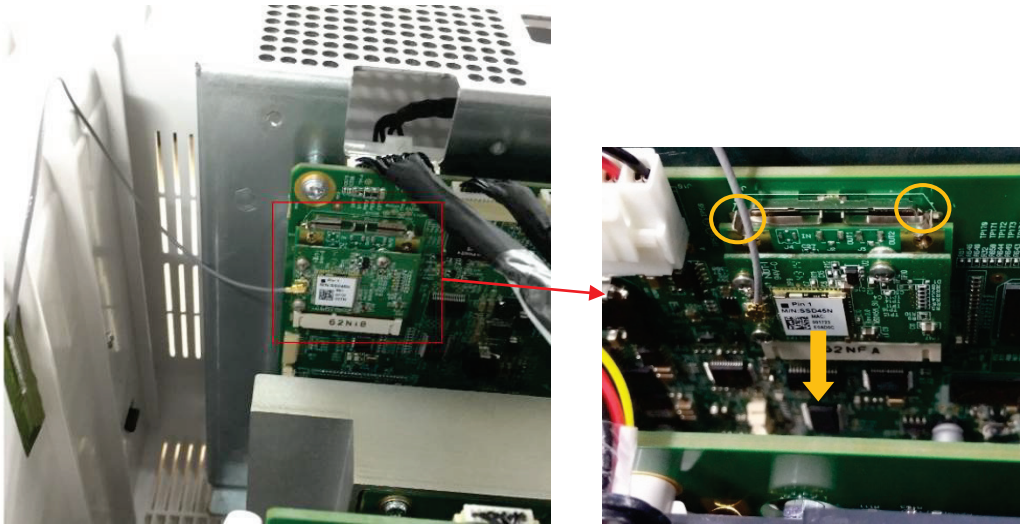
2. Tear the MPAN antenna fixing piece. Then, the MPAN antenna can be removed.

NOTE

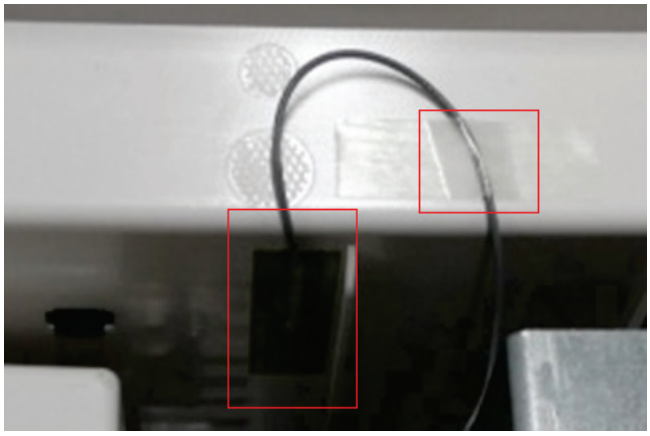
- **Use proper force to remove the cable carefully lest it would be broken.**

7.5.4 Removing the Wi-Fi Module

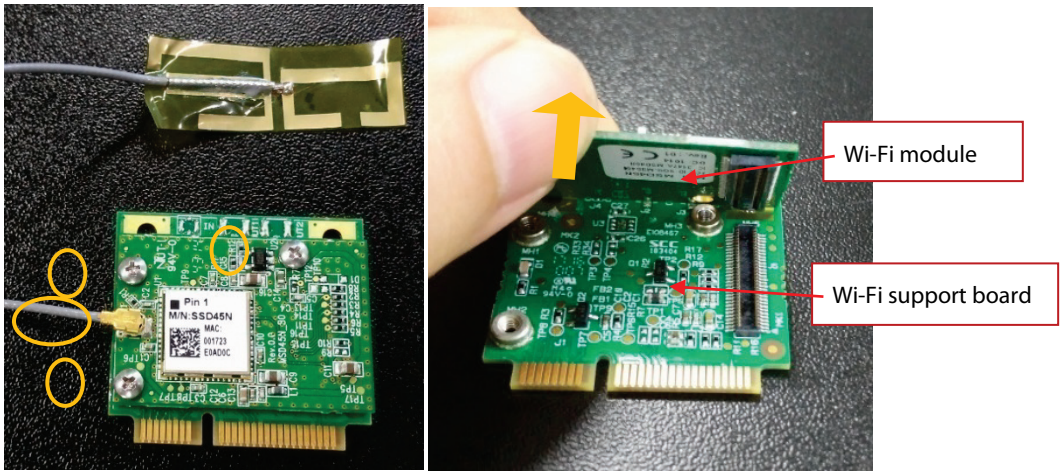
1. Press the clips at two sides of the Wi-Fi socket, and take out the Wi-Fi module from the socket.



2. Remove the adhesive tape fixing the antenna, and tear off the Wi-Fi sticker antenna.



3. Pull out the Wi-Fi antenna plug from the board; unscrew the three M2X4 screws, and separate the Wi-Fi module from the Wi-Fi support board.



NOTE

- **Use proper force to remove the cable carefully lest it would be broken.**
- **Use proper force to separate the board carefully, lest the board socket and golden finger part would be damaged. Provides application tips or other useful information to ensure that you maintain your product better.**

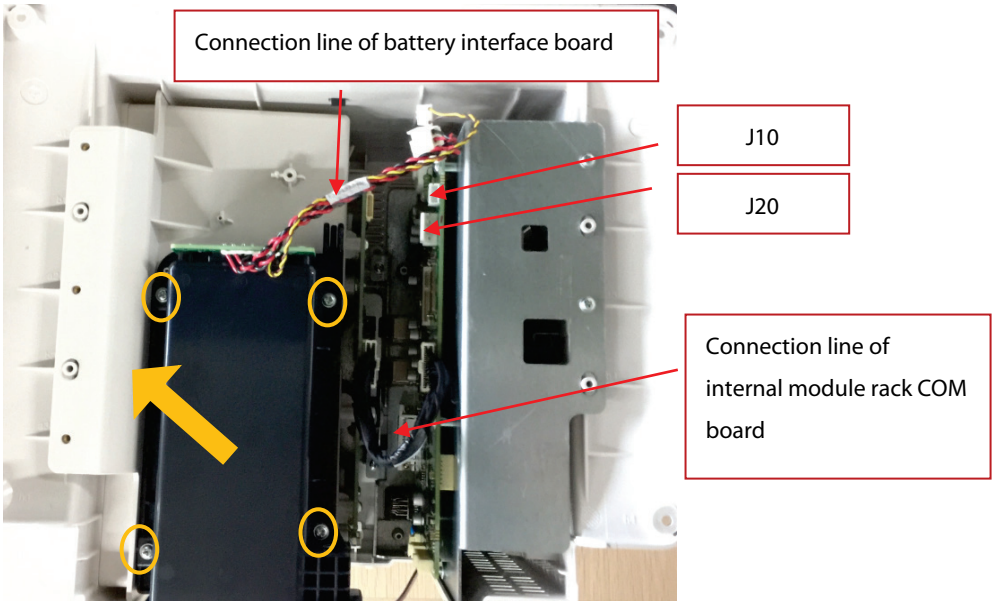
7.5.5 Removing the Internal Module Rack Assembly

NOTE

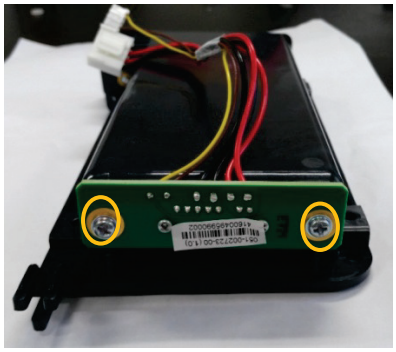
- **Release the clips on the connection line socket before disconnecting the connection line, lest the cable would be broken.**

■ N12/M12

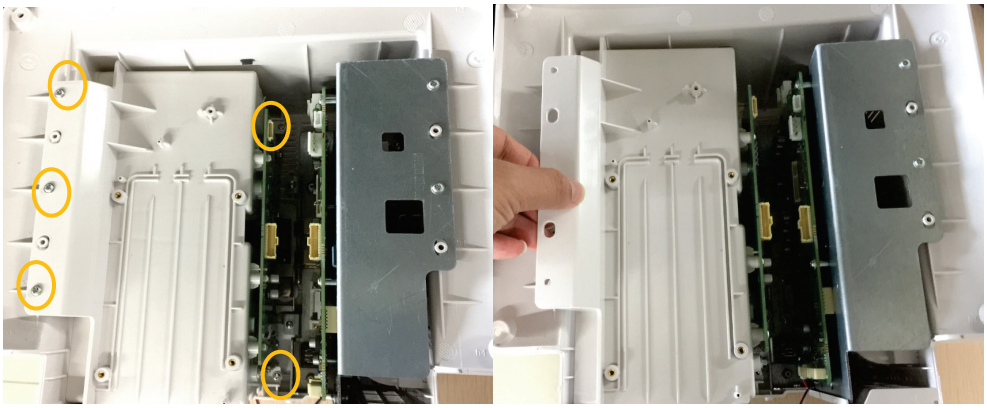
1. Remove the connection line of battery interface board from the main board end, and then take out the connection line of internal module rack COM board; unscrew the four M3X6 screws, and force upward to take out the battery cavity assembly as indicated in the figure.



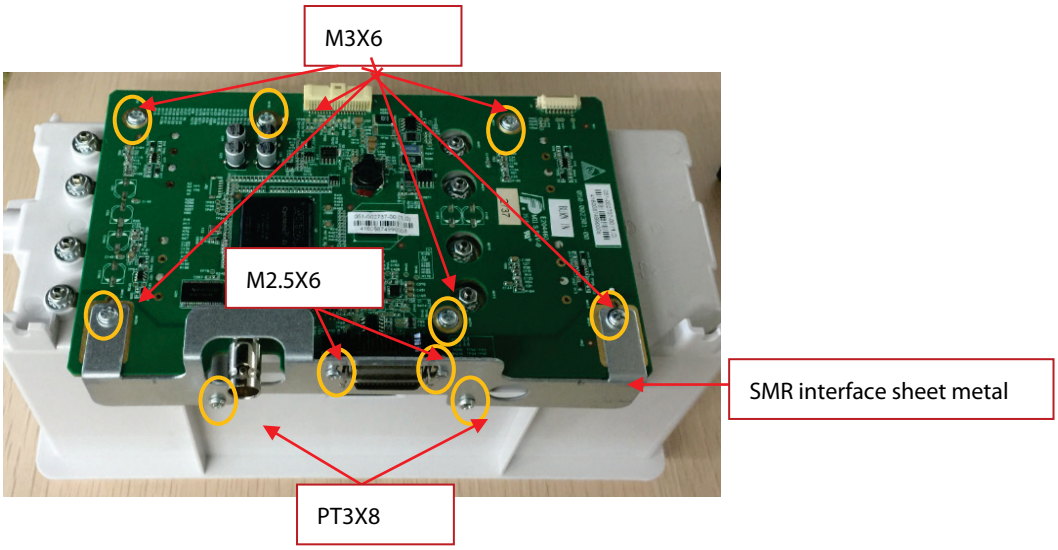
2. Loosen and remove the two M3X6 screws, and remove the battery interface board.



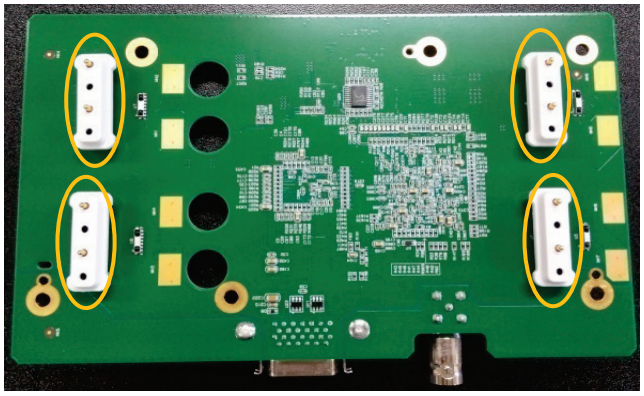
3. Loosen and remove the five M3X6 screws, and force upward vertically to remove the internal module rack assembly as indicated in the figure.



4. Place the face of the removed module rack assembly board up. First unscrew the two M2.5X6 screws on the SMR interface, the two PT3X8 screws, and the six M3X6 screws in turn, and then take down the internal module rack COM board.

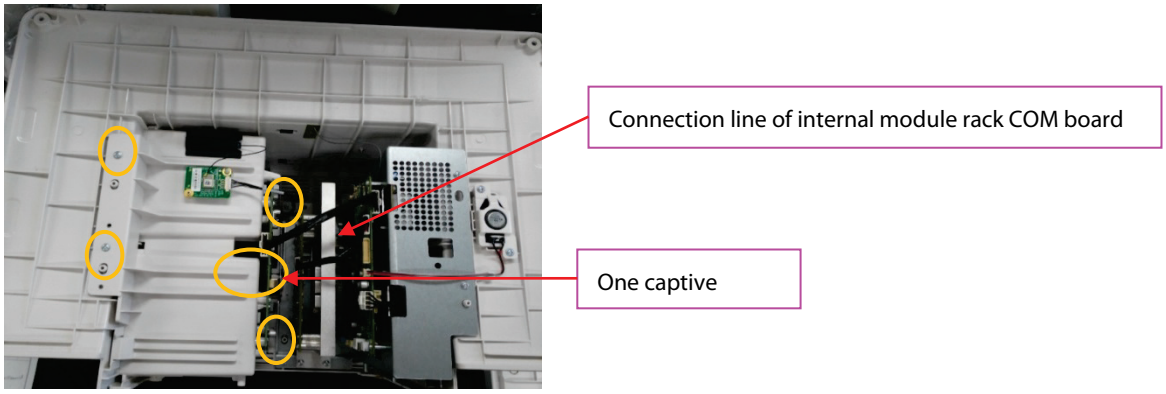


5. Turn over the removed internal module rack COM board, and take down the four POGO PIN silicon cases.

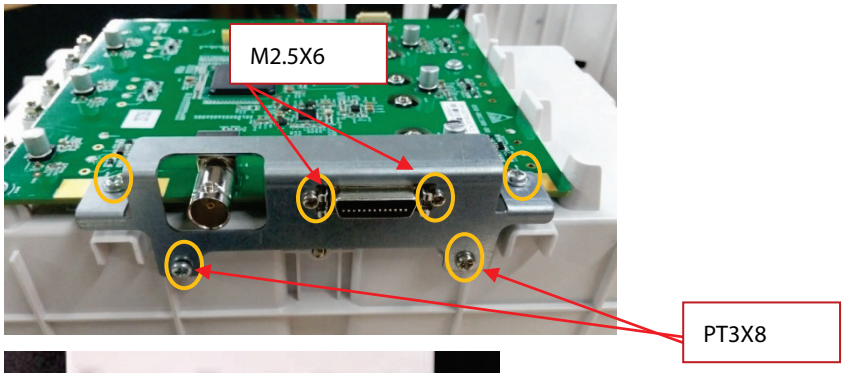


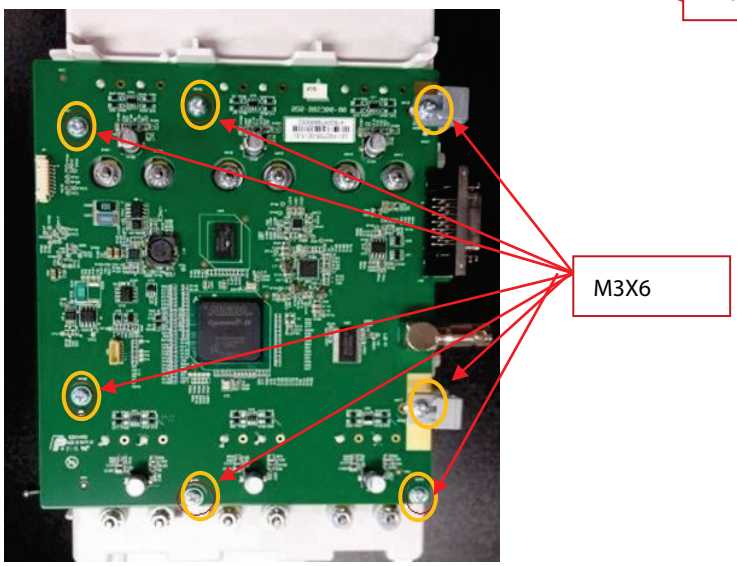
■ N15/M15/N17/M17

1. First remove the connection line of internal module rack COM board; unscrew the four M3X6 screws according to the positions shown below, and loosen one captive screw; force upward vertically to remove the module rack assembly as indicated in the figure.

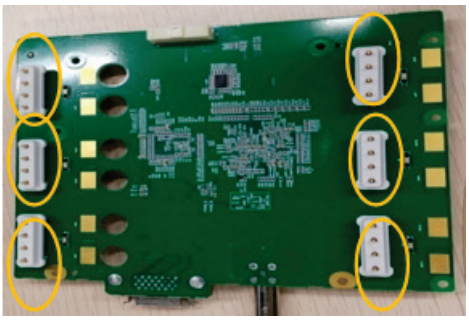


2. Place the face of the removed module rack assembly board up. First unscrew the two M2.5X6 screws on the SMR interface, the two PT3X8 screws, and the seven M3X6 screws in turn, and then take down the internal module rack COM board.





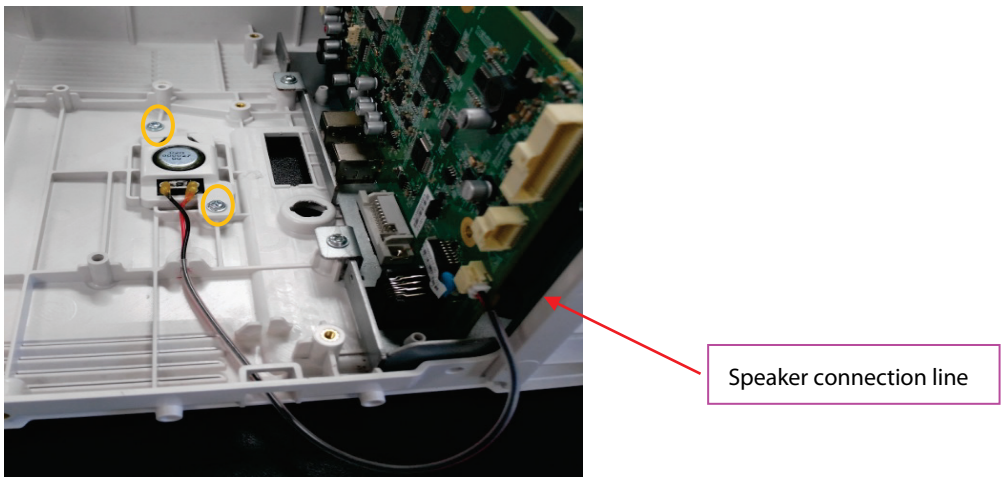
3. Turn over the removed internal module rack COM board, and take down the six POGO PIN silicon cases.



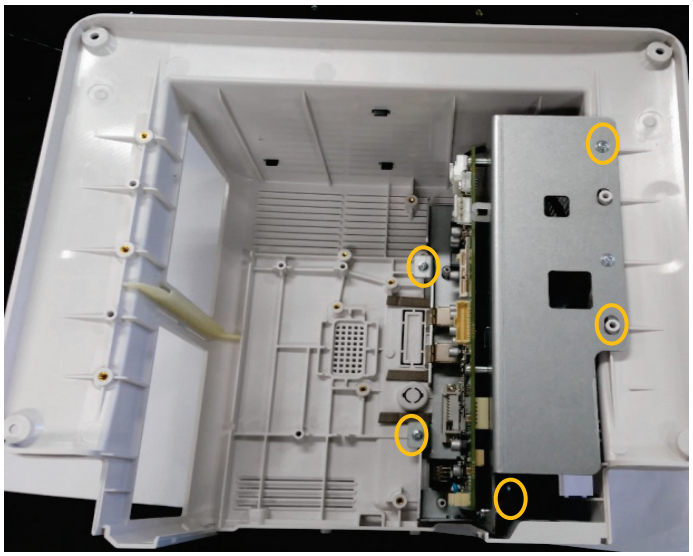
7.5.6 Removing the Main Support Assembly

- N12/M12

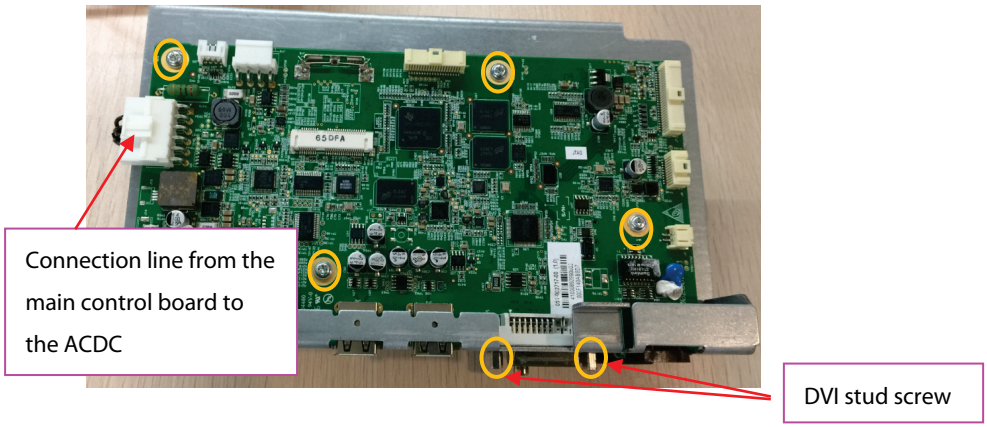
1. Pull out the speaker connection line, unscrew the two M3X6 screws, and take down the speaker assembly.



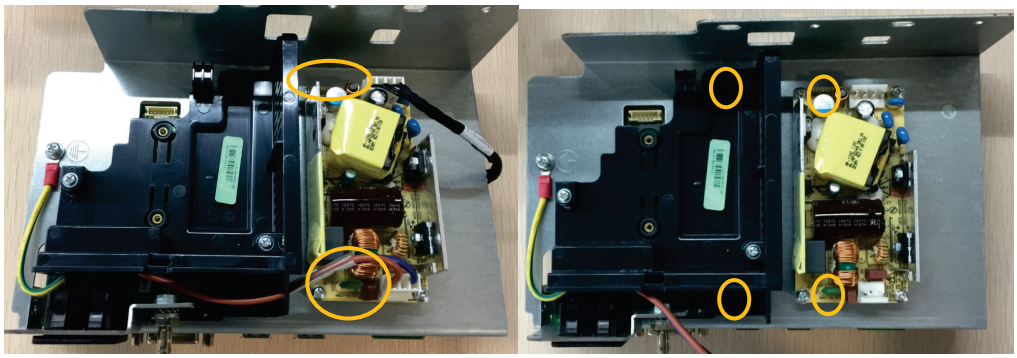
2. Loosen and remove the five M3X6 screws, and vertically take out the main support assembly.



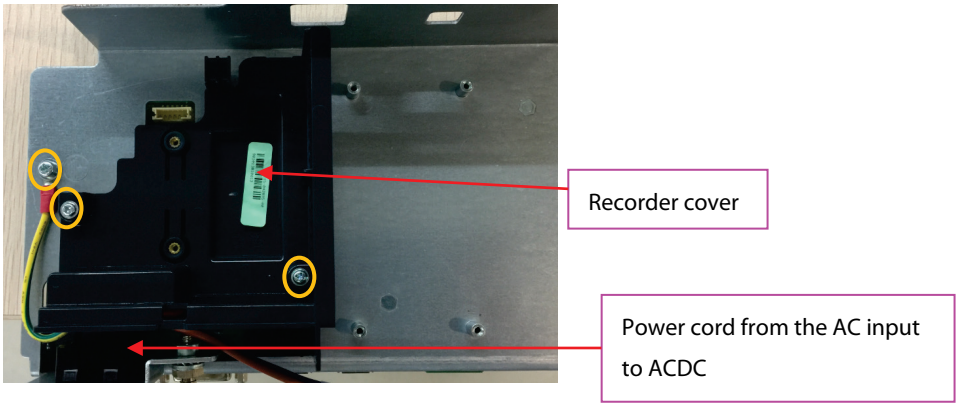
3. As shown in the figure below, place the face of the removed main board of main support up, pull out the connection line from the main control board to the ACDC and insert it in the main board end, unscrew the two DVI stud screws and four M3X6 screws, and then take out the main control board.



4. Turn over the main support with the main control board removed, and place its face up; remove the connection line from the main control board to the ACDC, and insert it into the ACDC power supply end; remove the power cord from the AC input to the ACDC, and insert it into the ACDC power supply end; unscrew four M3X6 screws, and take down the power board.

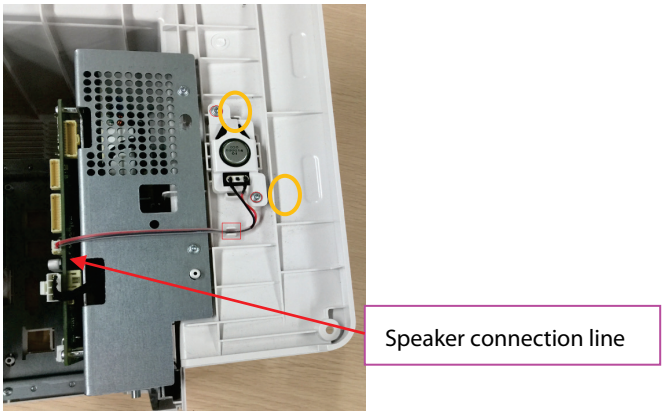


5. Loosen and remove two M3X6 screws, and take out the recorder cover; unscrew one M3X6 screw, and take out the power cord from the AC input to ACDC.

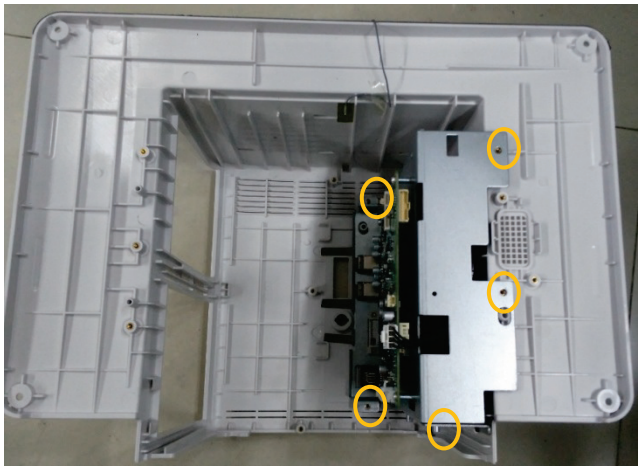


■ N15/M15/N17/M17

1. Pull out the speaker connection line, loosen and remove the two M3X6 screws, and take down the speaker assembly.

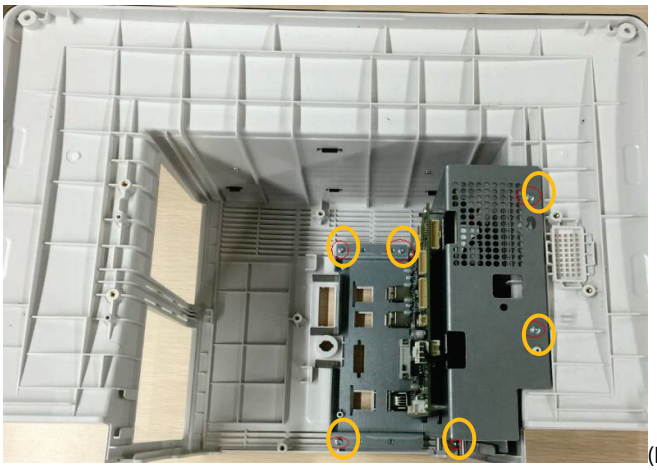


2. As shown below, for the N15/M15 series machine, loosen and remove the five M3X6 screws, and vertically take out the main support assembly.



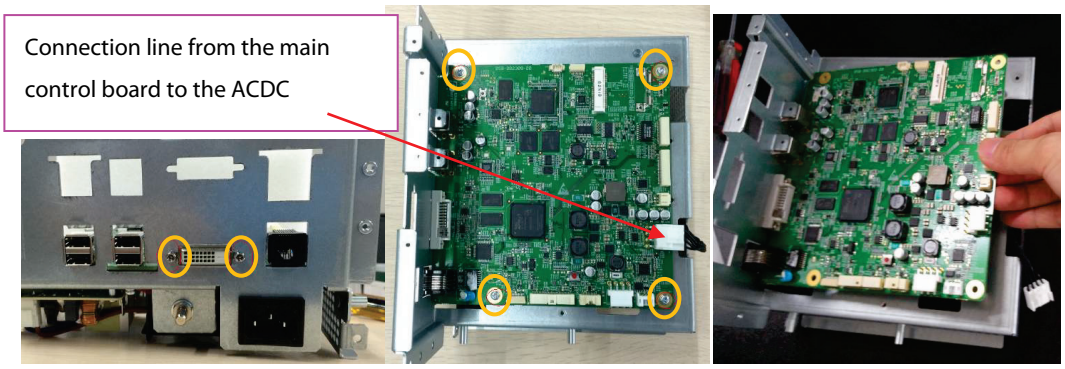
(N15)

As shown below, for the N17/M17 series machine, loosen and remove the six M3X6 screws, and vertically take out the main support assembly.

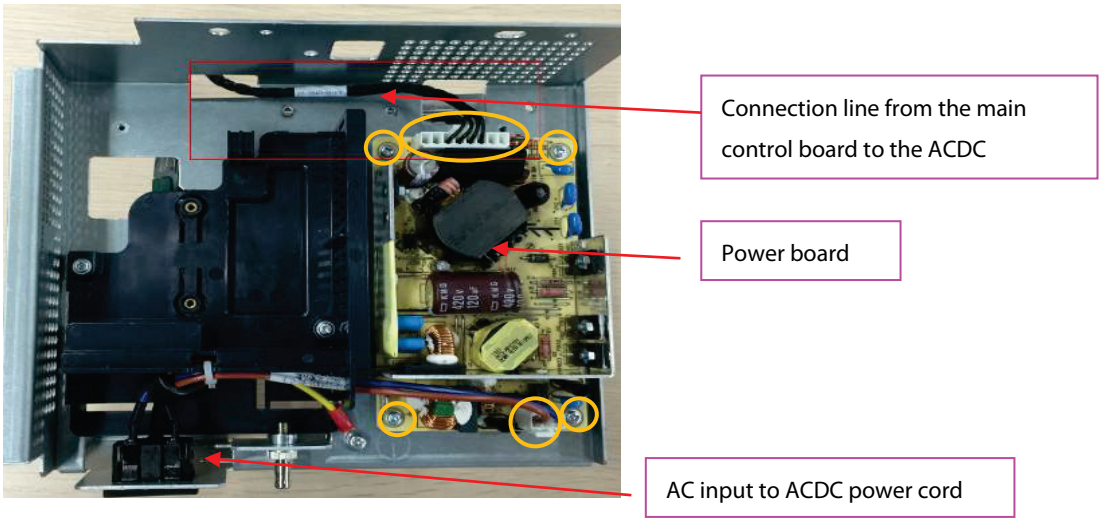


(N17)

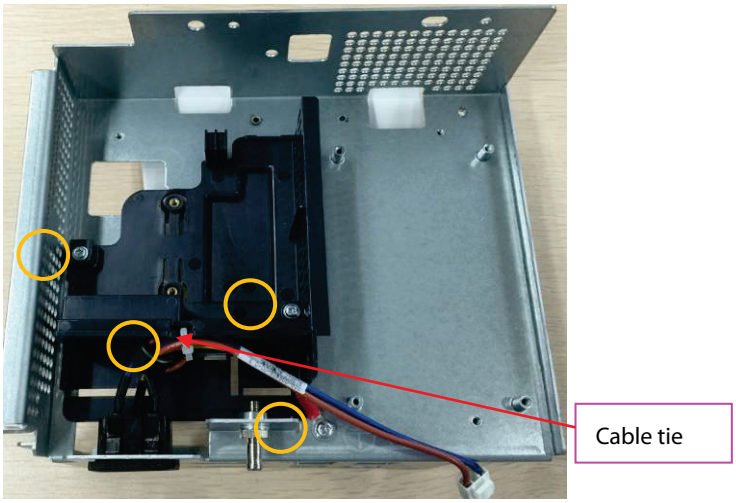
3. As shown in the figure below, place the face of the removed main board of main support up, pull out the connection line from the main control board to the ACDC and insert it in the main board end, loosen and remove the two DVI stud screws and four M3X6 screws, and then take out the main control board.



4. Turn over the main support with the main control board removed, and place its face up; remove the connection line from the main control board to the ACDC, and insert it into the ACDC power supply end; remove the power cord from the AC input to the ACDC, and insert it into the ACDC power supply end; loosen and remove four M3X6 screws, and take down the power board.



5. Cut off the cable tie on the connection line, loosen and remove the two M3X6 screws, and take out the recorder cover; loosen and remove one M3X6 screw, and take out the power cord from the AC input to ACDC.



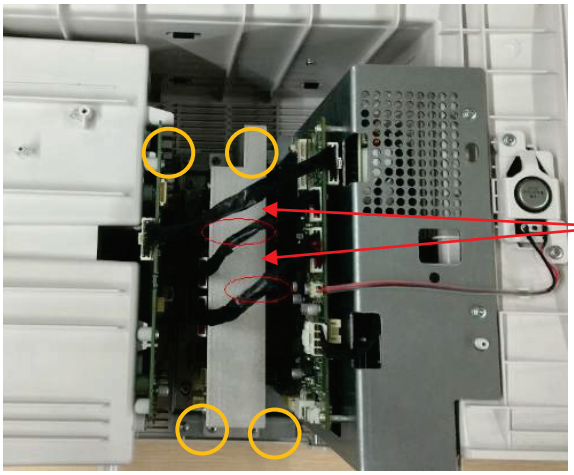
NOTE

- **Do not injure the cable when cutting the cable tie.**

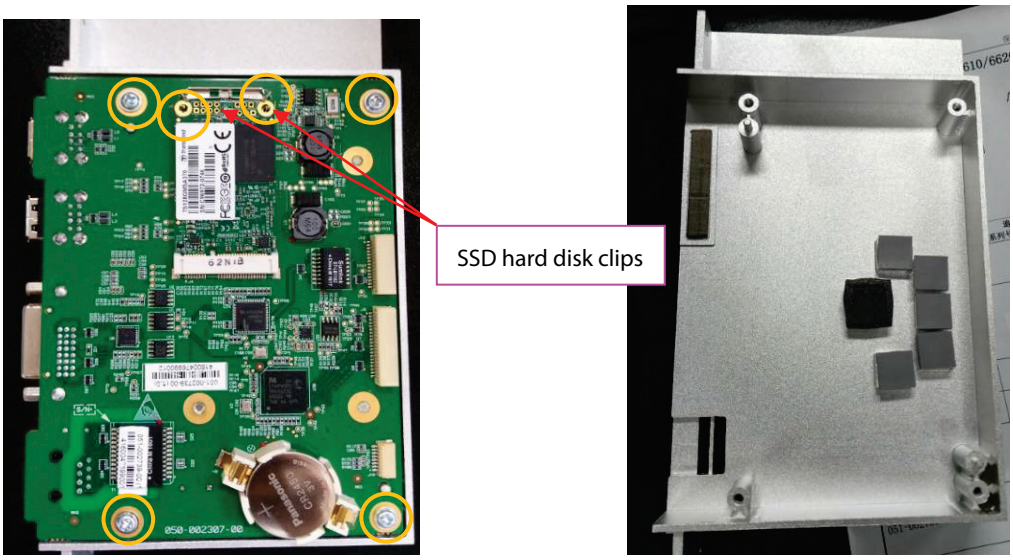
7.5.7 Removing the iView Board Assembly (N17 Series)

1. First screw out the two DVI stud screws.

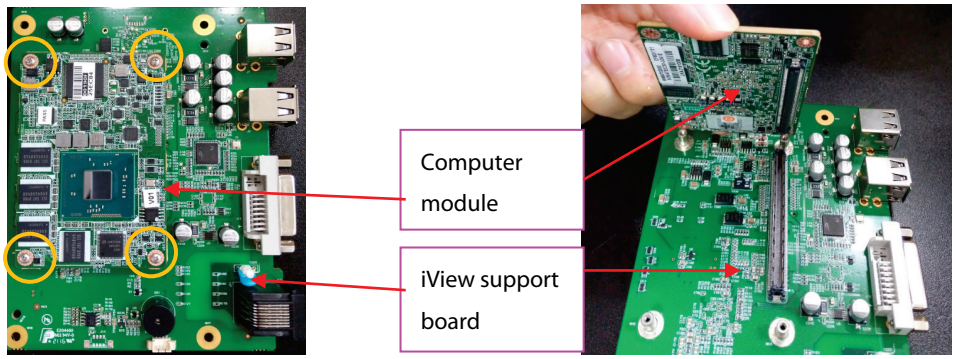
2. Remove the two iView board connection lines and the internal module rack connection line, loosen and remove the four M3X6 screws, and then take out the iView board assembly.



3. Place the face of the removed iView board assembly board up, and take down the SSD hard disk by pressing the SSD hard disk clips; loosen and remove the four M3X6 screws, and take down the iView board.



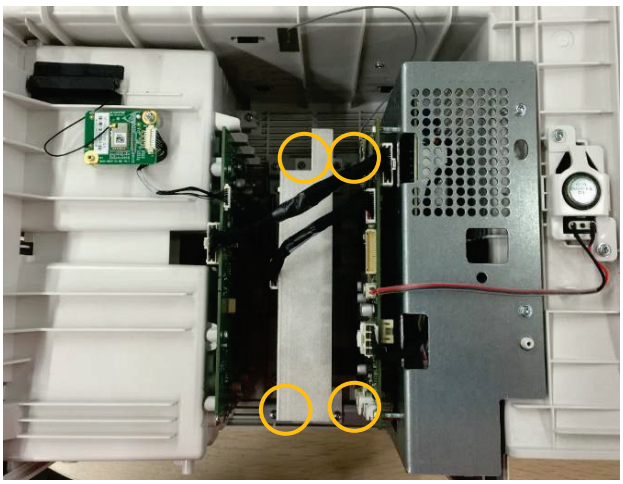
4. As shown below, place up the face of the iView board side with the computer module, loosen and remove the four M2X6 screws, and separate the computer module from the iView support board.



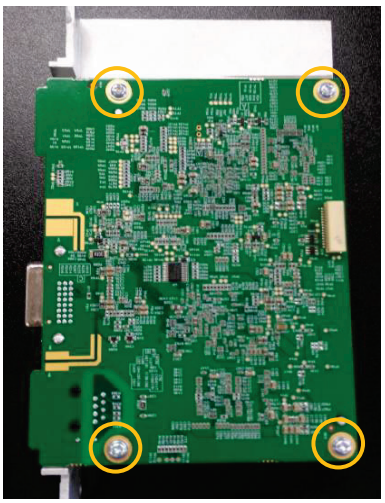
7.5.8 Removing the Independent Display Board Assembly (N17/M17 Series)

1. First screw out the two DVI stud screws.

2. Remove the independent display board connection line and the internal module rack connection line, loosen and remove the four M3X6 screws, and then take out the independent display board assembly.

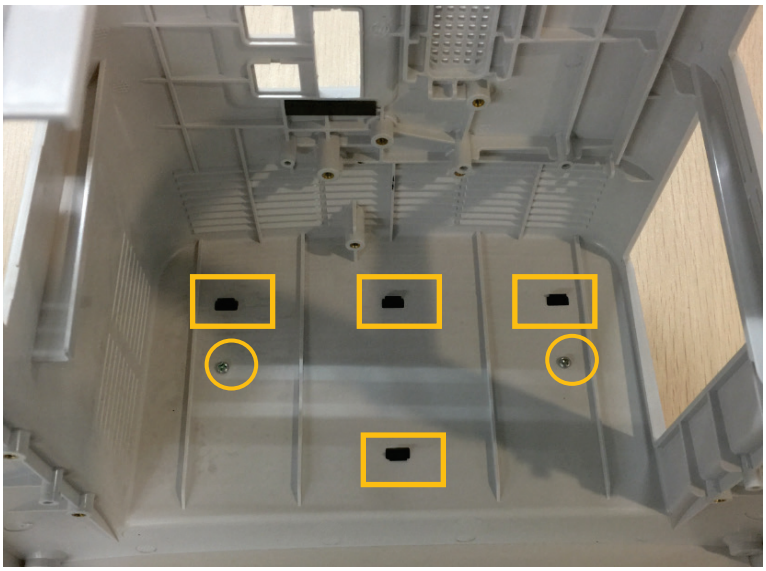


3. Loosen and remove the four M3X6 screws, and take down the independent display board.



7.5.9 Removing the Handle

1. Place the face of the rear case handle down, loosen and remove the two PT 3X8 screws, forcibly release the four clips on the top cover of rear case, and push down to take out the top cover of rear case.

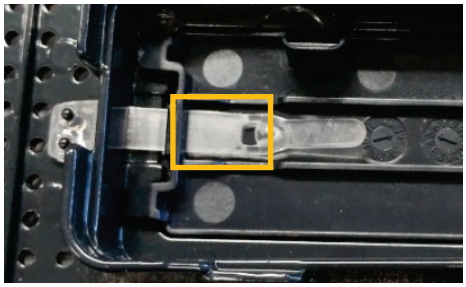


2. Pry open the two handle positioning pins to the middle direction, and take out the handle.

7.6 Further Disassembly of the Base Assembly

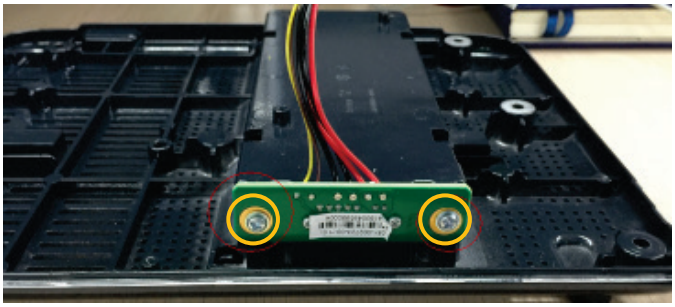
- N12/M12

Take out the battery door connecting belt from the through hole, and remove the battery door.

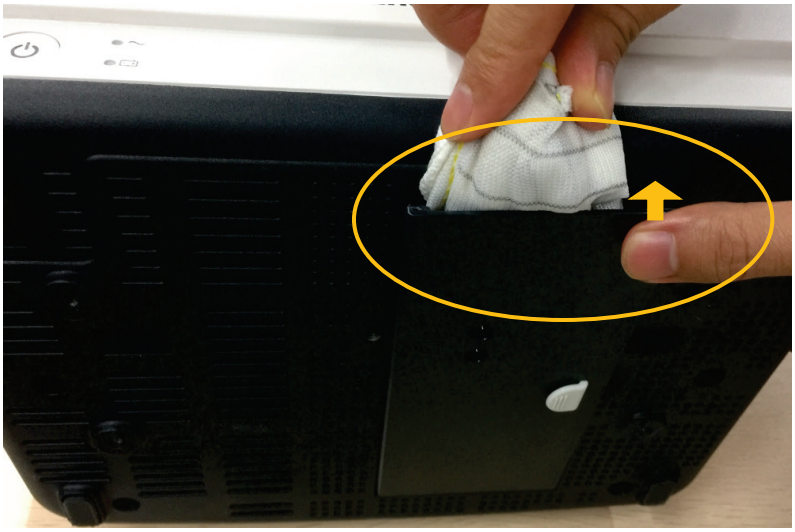


■ N15/M15/N17/M17

1. Loosen and remove the two M3X6 screws, and remove the battery interface board.



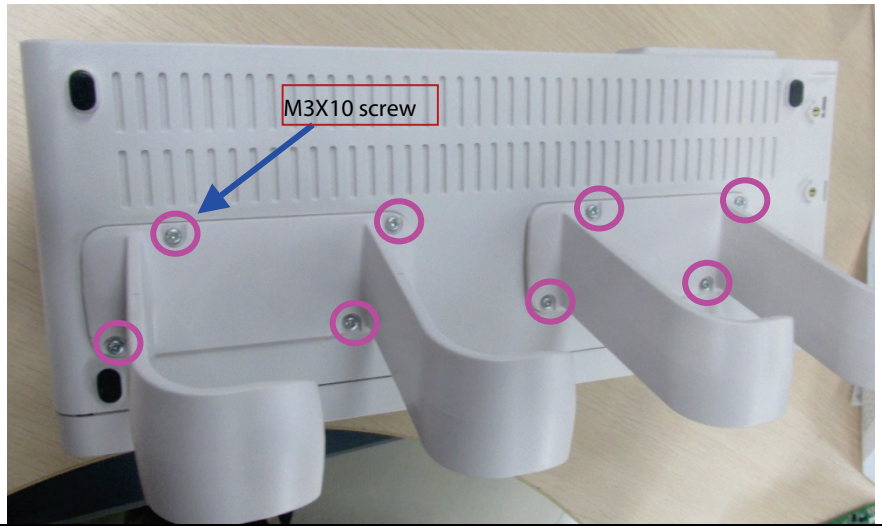
2. As shown below, open the battery door, insert a piece of cloth into the gap between the battery door and the base, and forcedly press down to take out the battery door.



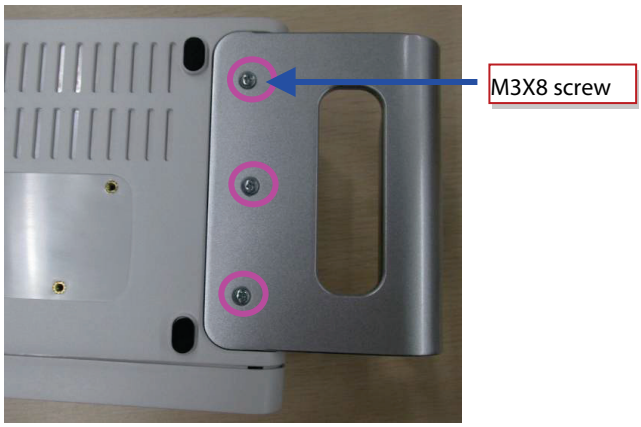
7.7 Disassembling the Module Rack

1. Removing the handle and hooks

   ◆ As shown in the following figure, loosen and remove the eight M3X10 cross recessed countersunk head screws, and remove the hooks.

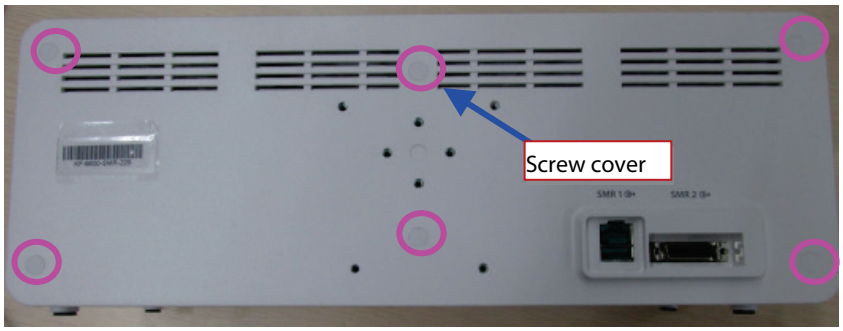


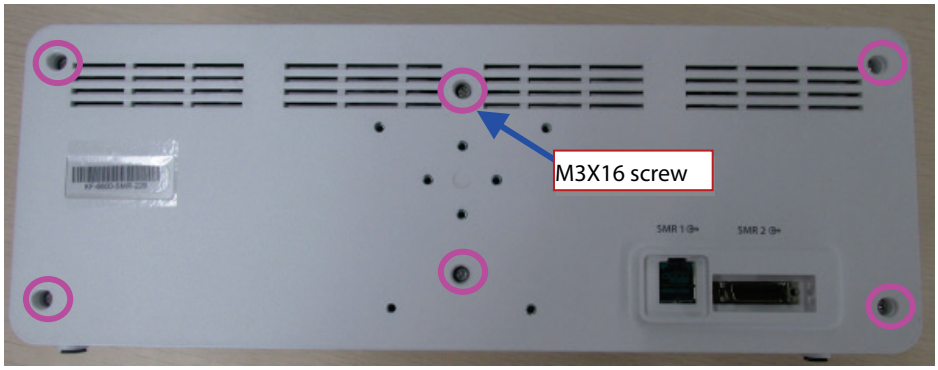
◆ As shown in the following figure, loosen and remove the three M3×8 cross recessed countersunk head screws, and remove the handle.



2. Removing the rear case of module rack

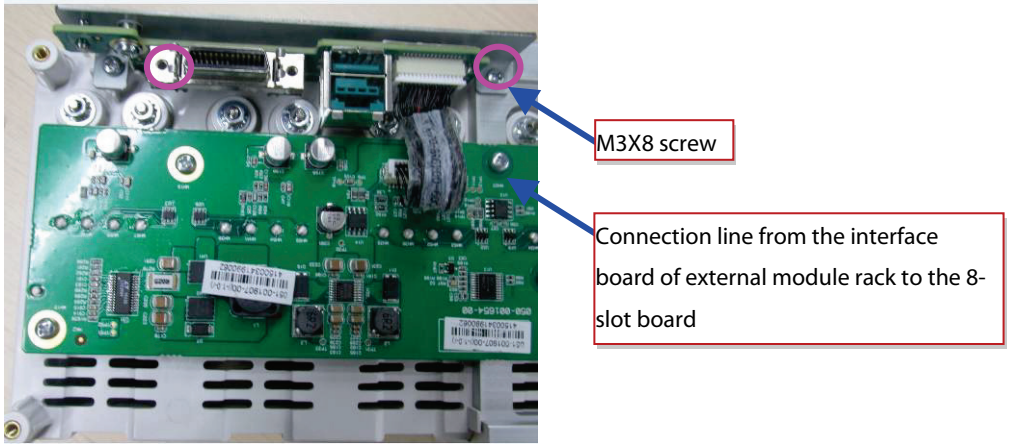
As shown in the following figure, use a tweezer to take out the six screw covers on the rear case, loosen and remove the six M3X16 cross recessed pan head screw, and separate the front case from the rear case.





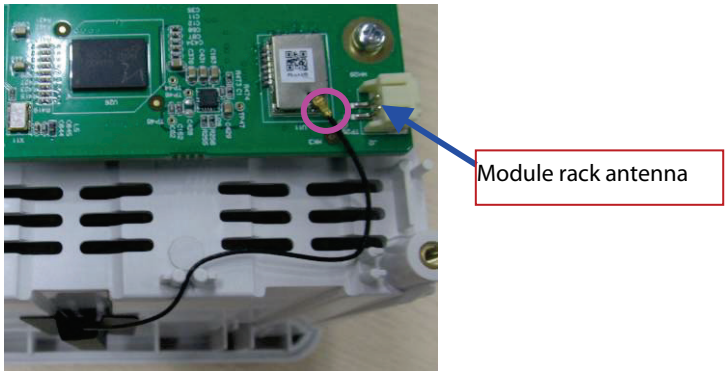
3. Removing the module rack interface board

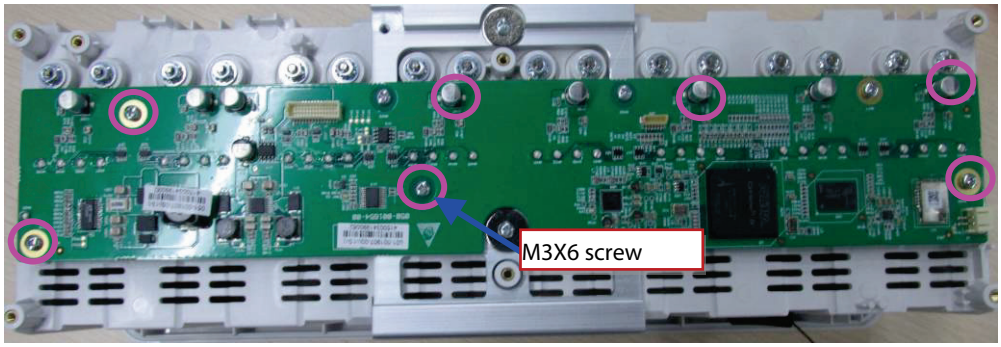
Loosen and remove the two M3X8 cross recessed pan head screws, pull out the connection line between the interface board and the internal module rack COM board, and then take out the interface board.

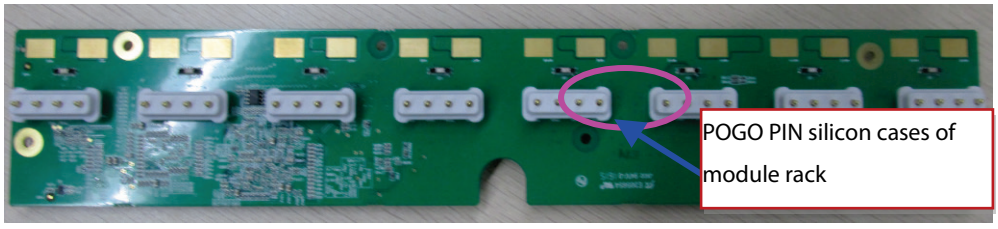


4. Removing the internal module rack COM board.

   Pull out the connection line between the module rack antenna and the internal module rack COM board, loosen and remove the seven M3X8 cross recessed pan head screws on the internal module rack COM board, and take down the eight POGO PIN silicon cases of module rack.



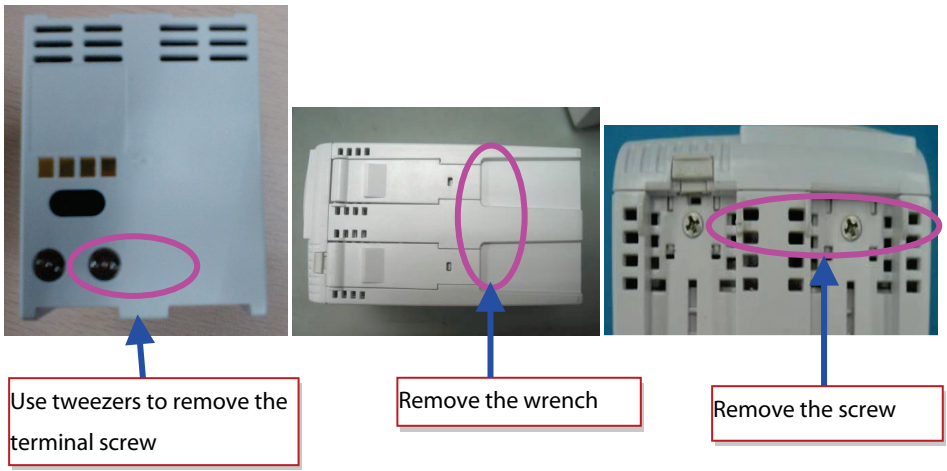




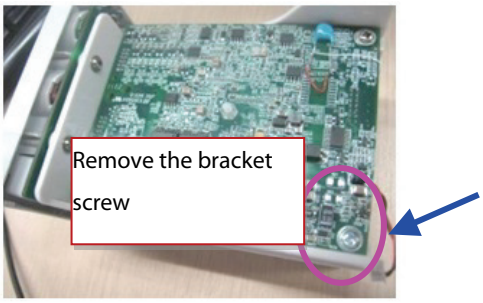
7.8 Disassembling the M51C Module

1. Removing the front panel assembly

   - As shown in the figure, use a tweezers to remove the screw for the back end terminal of the module; use a small flat-bladed screwdriver to remove the wrench; use a Phillips screwdriver to remove the front panel screw. Then, the front panel of module can be pulled out.

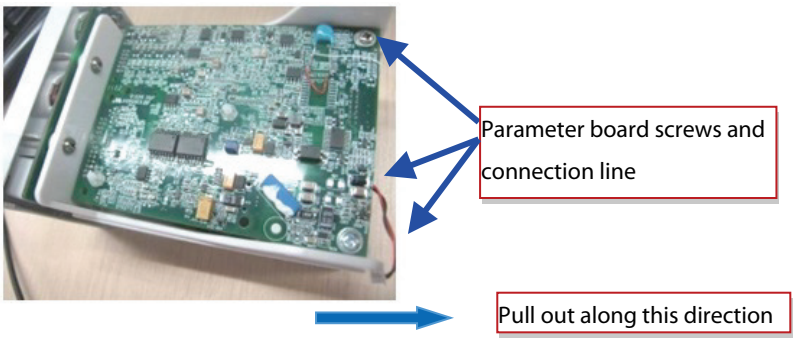


   - As shown in the following figure, loosen and remove the screw between the front panel and the bracket, and unplug the air tube at the air nozzle. Then the front panel can be removed.



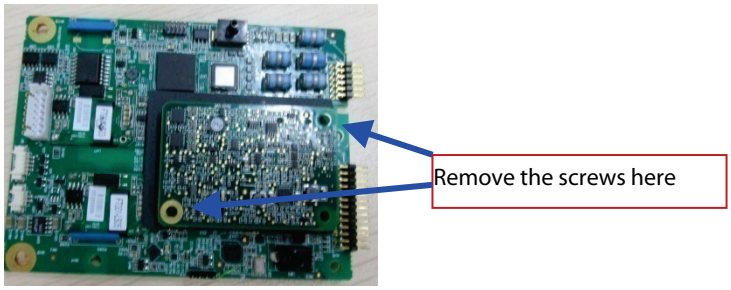
2. Remove the parameter board

   As shown in the following figure, loosen and remove the board screws, pull out the pump and valve connection line and NIBP air tube. Then, the parameter board can be removed.



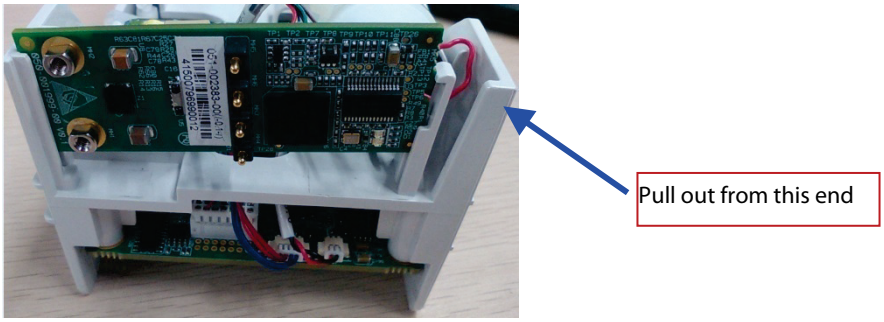
3. Removing the blood oxygen board

As shown in the following figure, remove the blood oxygen board screws, and then pull out the blood oxygen board.



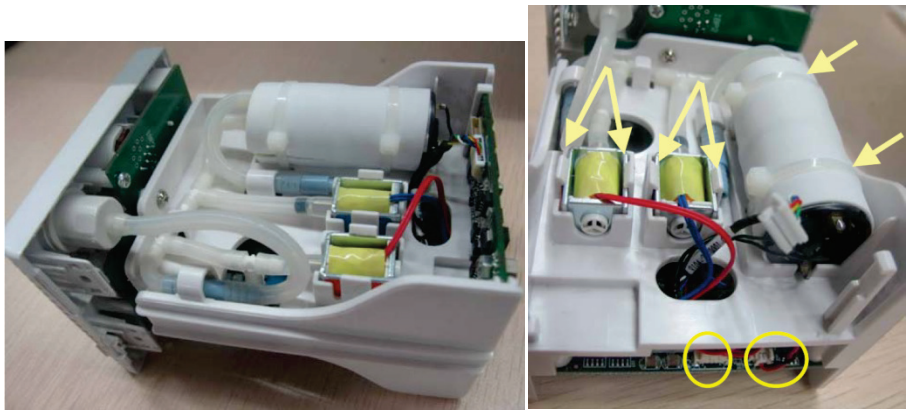
4. Removing the infrared board

As shown in the following figure, remove the infrared board connection line, and then remove the infrared board.



5. Removing the pump and valve

- As shown in the following figure, cut off the cable tie, unplug the pump power line and NIBP air tube, and then remove the pump.
- As shown in the figure, unplug the valve power line and NIBP air tube, use a flat-bladed screwdriver to poke the slots at two sides of the valve, and then remove the valve assembly.



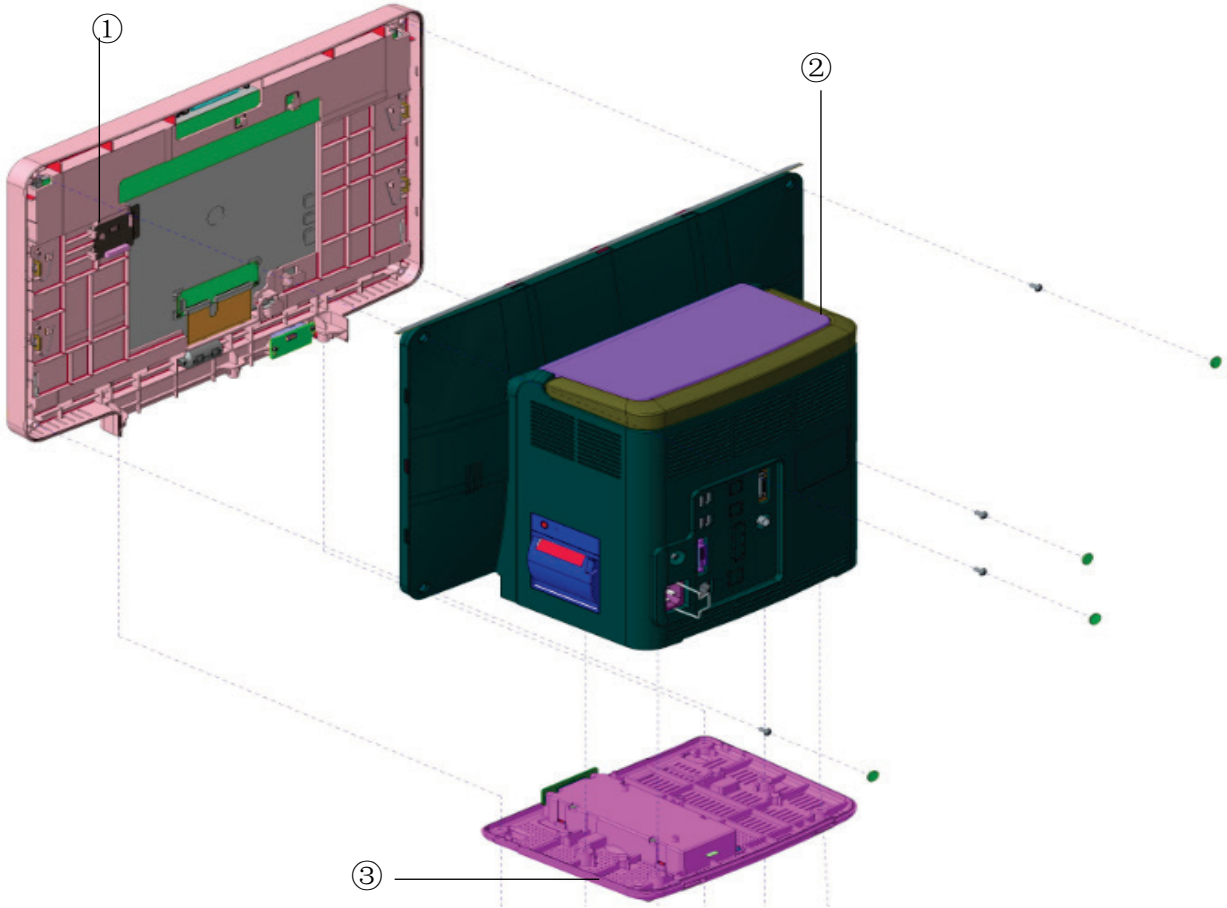
FOR YOUR NOTES

8 Parts

This chapter lists the exploded views and material codes of the parts including the monitor's main unit, SMR and parameter module. It helps the engineer to identify the parts during disassembly of the patient monitor and spare parts replacement.

8.1 N17/M17/N15/M15/N12/M12 Whole Unit

8.1.1 Exploded View

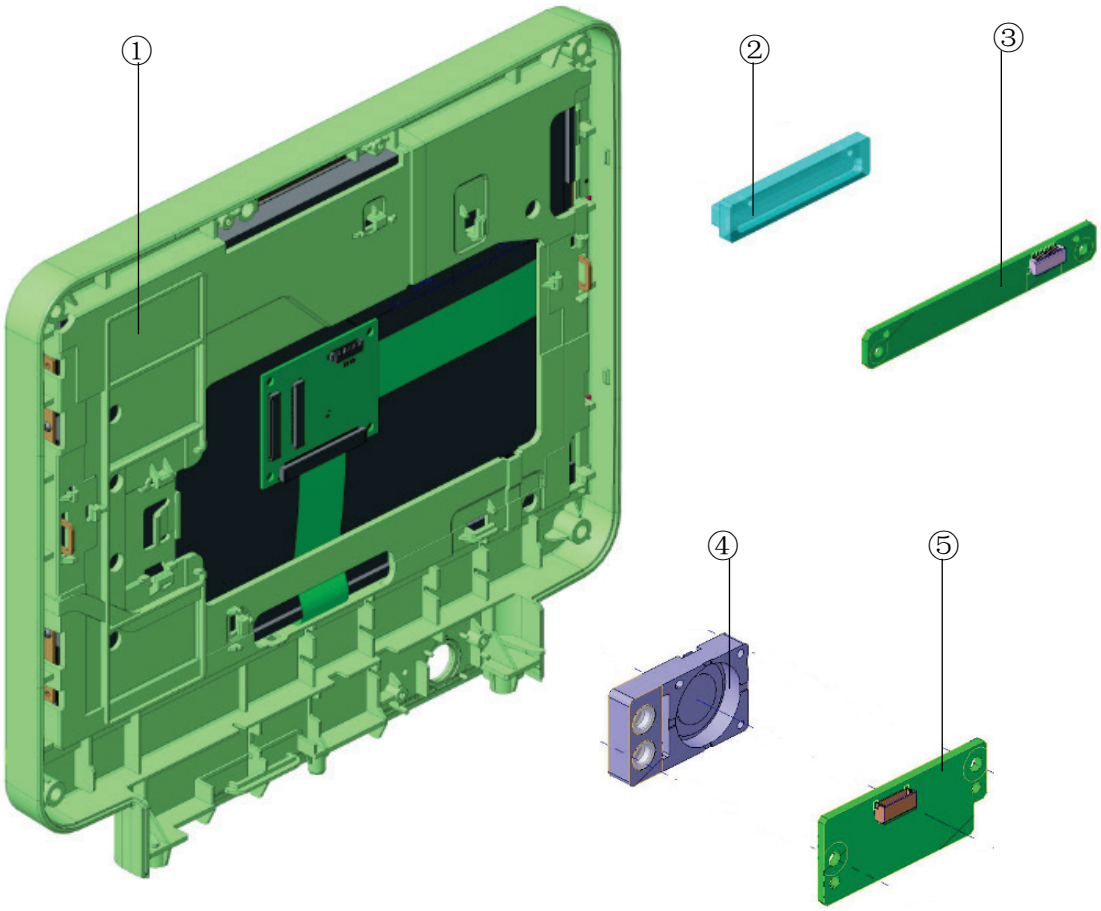


8.1.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	/	Front Housing view	1	/
2	/	Rear Housing view	1	/
3	/	Bottom Housing view	1	/

8.2 N12/M12 Front Housing view

8.2.1 Exploded View

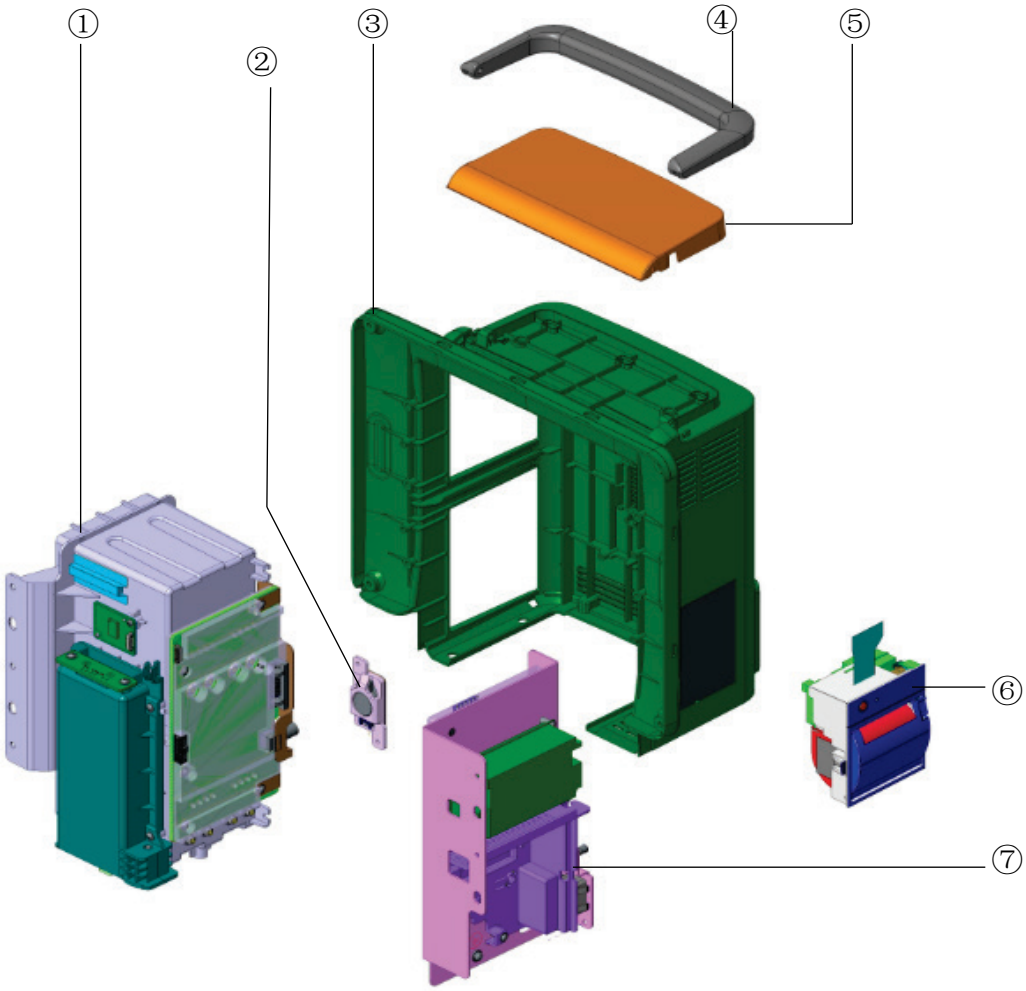


8.2.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-044502-00	N12-NLT front housing assembly (FRU)	1	Compatible with 115-044503-00
2	049-001135-00	MK alarm cap	1	/
3	051-002693-00	Alarm LED and Light Sensor Board PCBA	1	/
4	043-007956-01	MK POWER BUTTON(P+R)-ESM	1	/
5	051-002711-00	Power Switch and Indicate LED Board PCBA	1	/

8.3 N12/M12 Rear Housing View

8.3.1 Exploded View

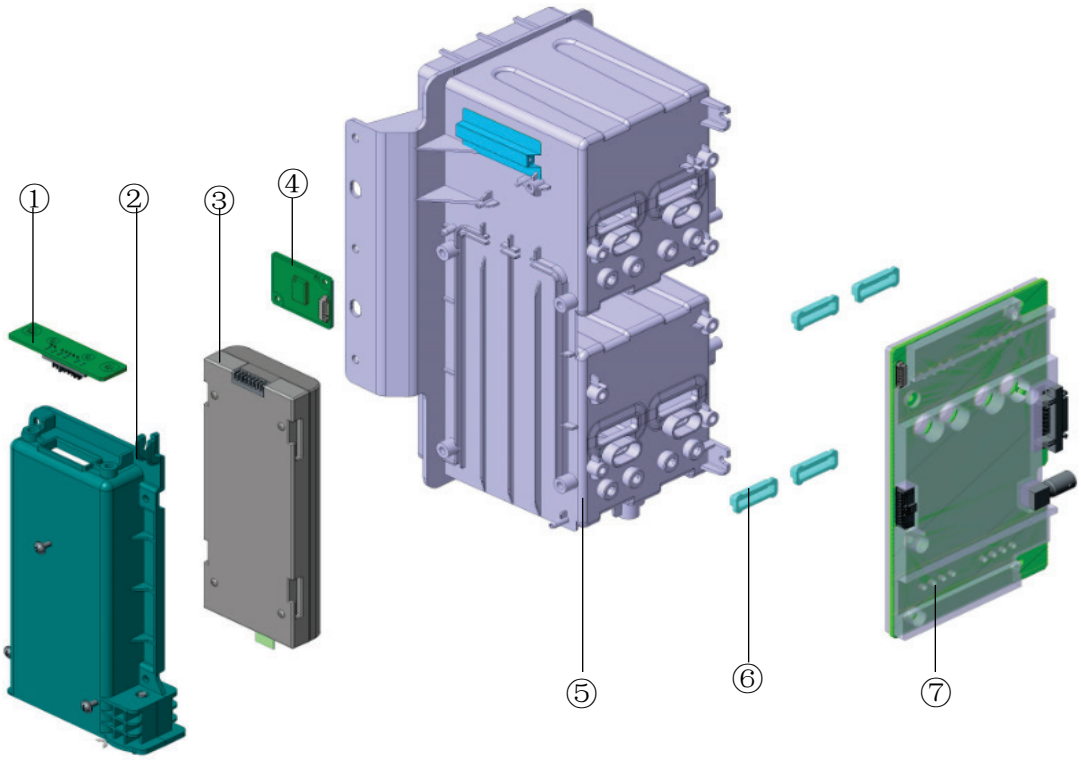


8.3.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	/	N12 internal module rack assembly	1	Refer to 1.4 N12/M12 Internal Module Rack Assembly
2	115-044509-00	N12 Speaker assembly(FRU)	1	/
3	115-044499-00	N12 rear housing assembly(FRU)		/
4	115-044501-00	N12 handle assembly(FRU)	1	/
5	043-007578-01	N12 Top cover（ESM）	1	/
6	115-044523-00	Recorder upgrade package	1	Include with 6800-20-50301
7	/	N12 main bracket assembly	1	Refer to 1.5 N12/M12 Main Bracket Assembly

8.4 N12/M12 Internal Module Rack Assembly

8.4.1 Exploded View

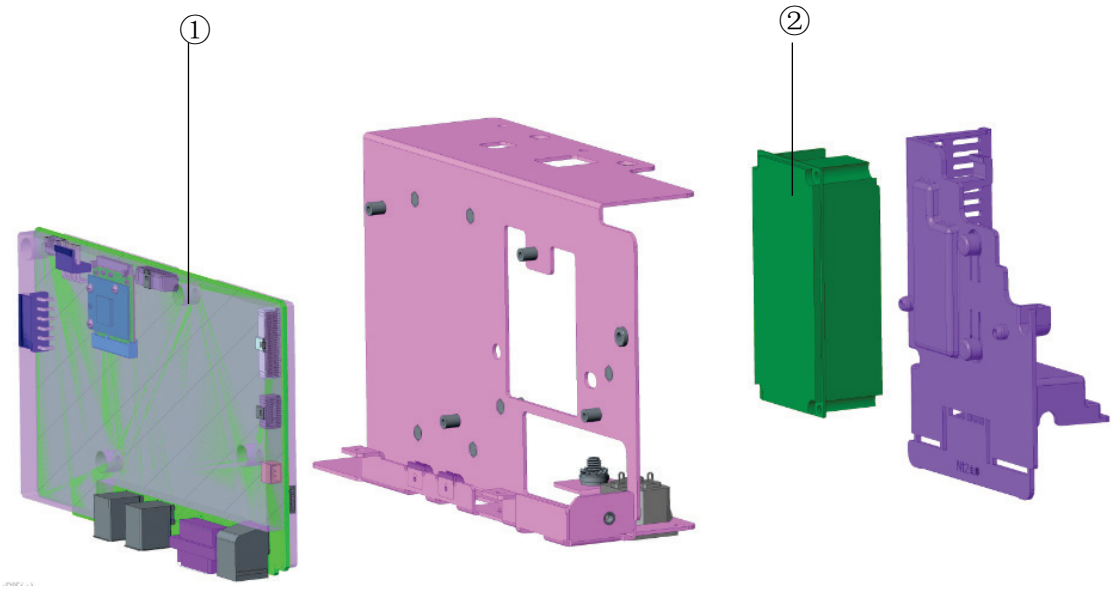


8.4.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	051-002723-00	Battery Interface Board PCBA	1	/
2	115-044504-00	N12 battery chamber assembly(FRU)	1	/
3	115-065140-00	Li-ion Bat Pack (11.1V4500mAh LI23S002A)	1	/
4	051-002738-00-00	MPAN carrier Board(FRU)	1	/
5	115-044507-00	N12 Module rack shell assembly	1	Infrared liens and contact screw parts number please refer to 1.19 Others
6	049-001230-00	pogo pin cover	4	/
7	051-002737-01-00	4Slot modular rack PCBA (FRU/TDS&BNC)	1	/
	051-002736-01-00	4Slot modular rack PCBA (without TDS&BNC)		/

8.5 N12/M12 Main Bracket Assembly

8.5.1 Exploded View



8.5.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-085697-00	N12 Mainboard（FRU/SW（N12)/Standard：without DVI)	1	/
	115-085698-00	N12 Mainboard（FRU/SW(N12C)/Standard：without DVI)		
	115-085699-00	M12 Mainboard（FRU/SW<M12>/Standard：without DVI)		
	115-085700-00	N12 Mainboard（FRU/SW（N12)/Fully configured：with DVI)		
	115-085701-00	N12 Mainboard (FRU/SW(N12C)/Fully configured：with DVI)		
	115-085702-00	M12 Mainboard（FRU/SW<M12>/Fully configured：with DVI)		/
2	022-000159-00	POWER SUPPLY BOARD 15V 63W	1	/

8.6 N12/M12 Bottom Housing

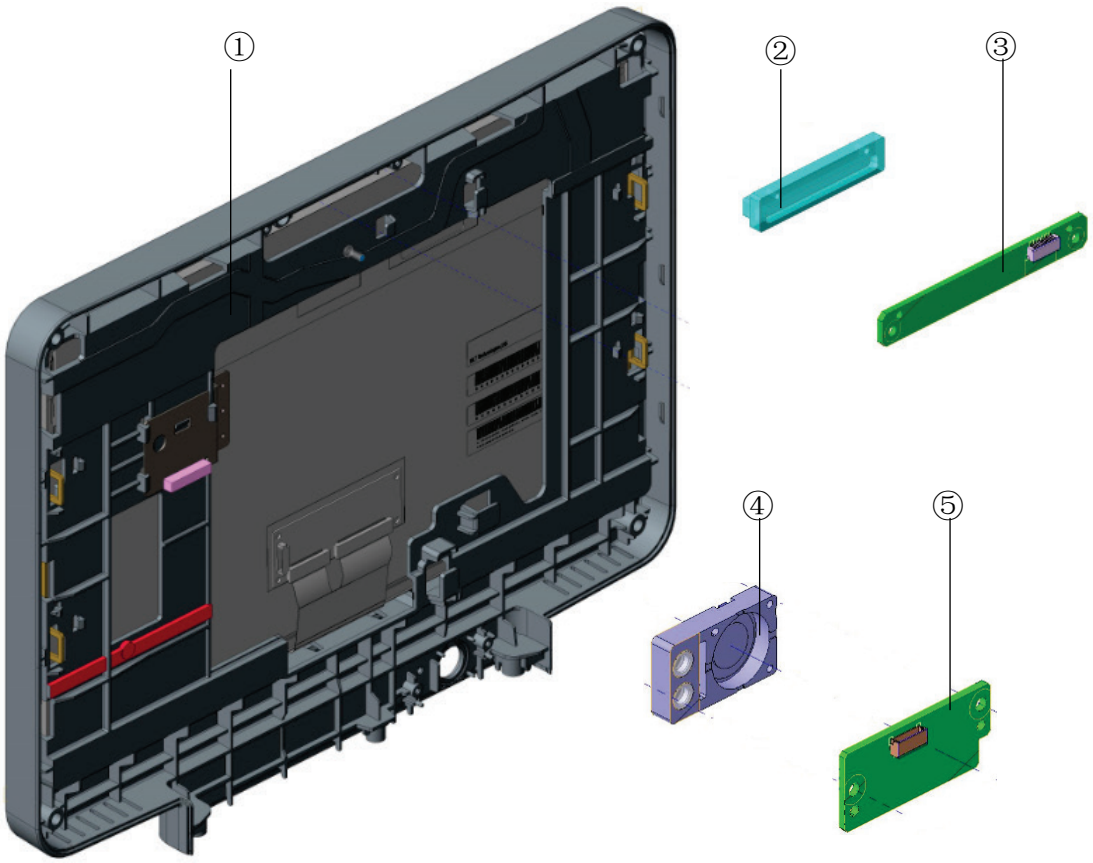
8.6.1 Exploded View

8.6.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-044520-00	N12 bottom housing assembly(FRU)	1	Include with 115-044505-00
2	115-044505-00	N12 battery door assembly(FRU)	1	/

8.7 N15/M15 Front Housing View

8.7.1 Exploded View

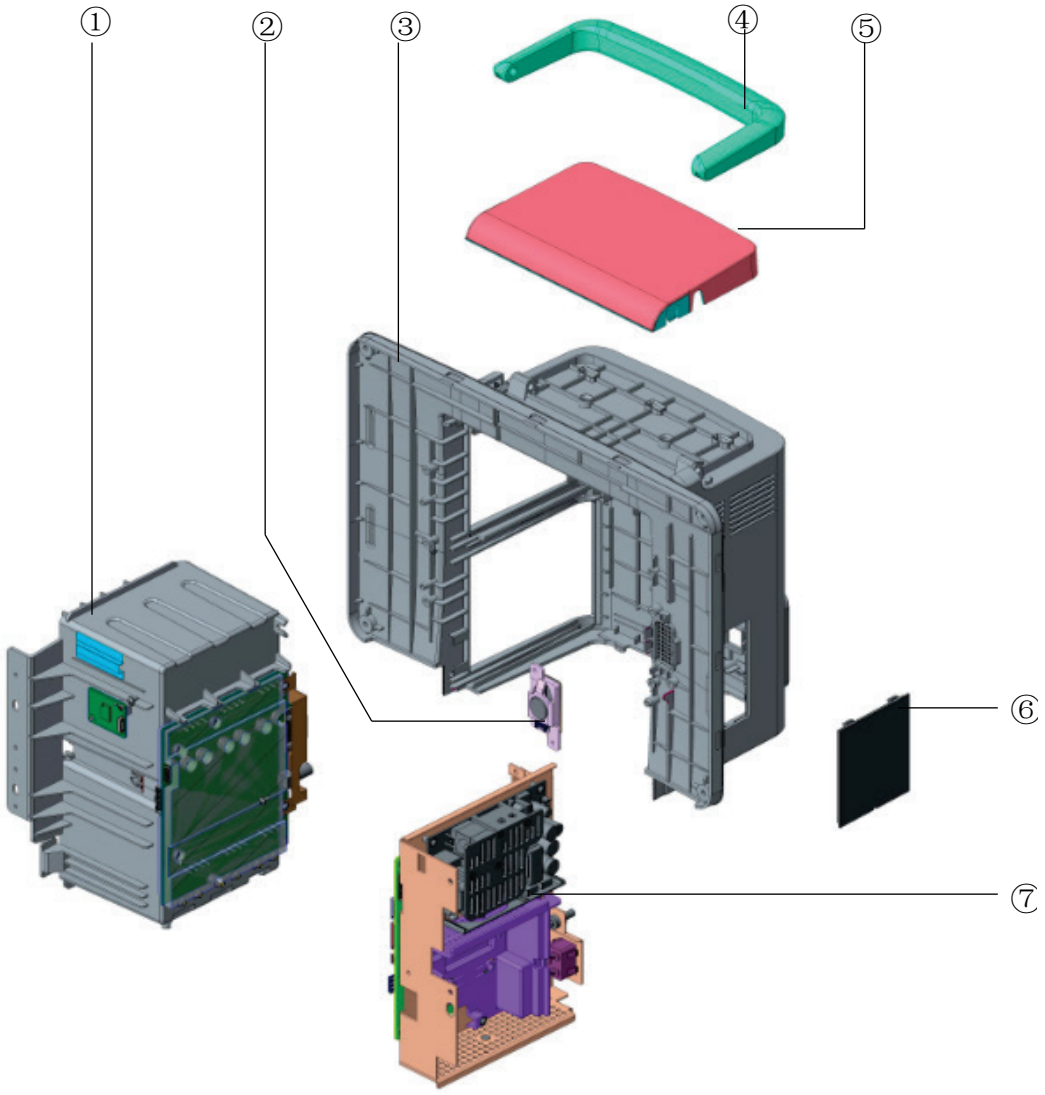


8.7.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-044544-00	N15-NLT front housing assembly (FRU)	1	Compatible with 115-044545-00
2	049-001135-00	MK alarm cap	1	/
3	051-002693-00	Alarm LED and Light Sensor Board PCBA	1	/
4	043-007956-01	MK POWER BUTTON(P+R)-ESM	1	/
5	051-002711-00	Power Switch and Indicate LED Board PCBA	1	/

8.8 N15/M15 Rear Housing View

8.8.1 Exploded View

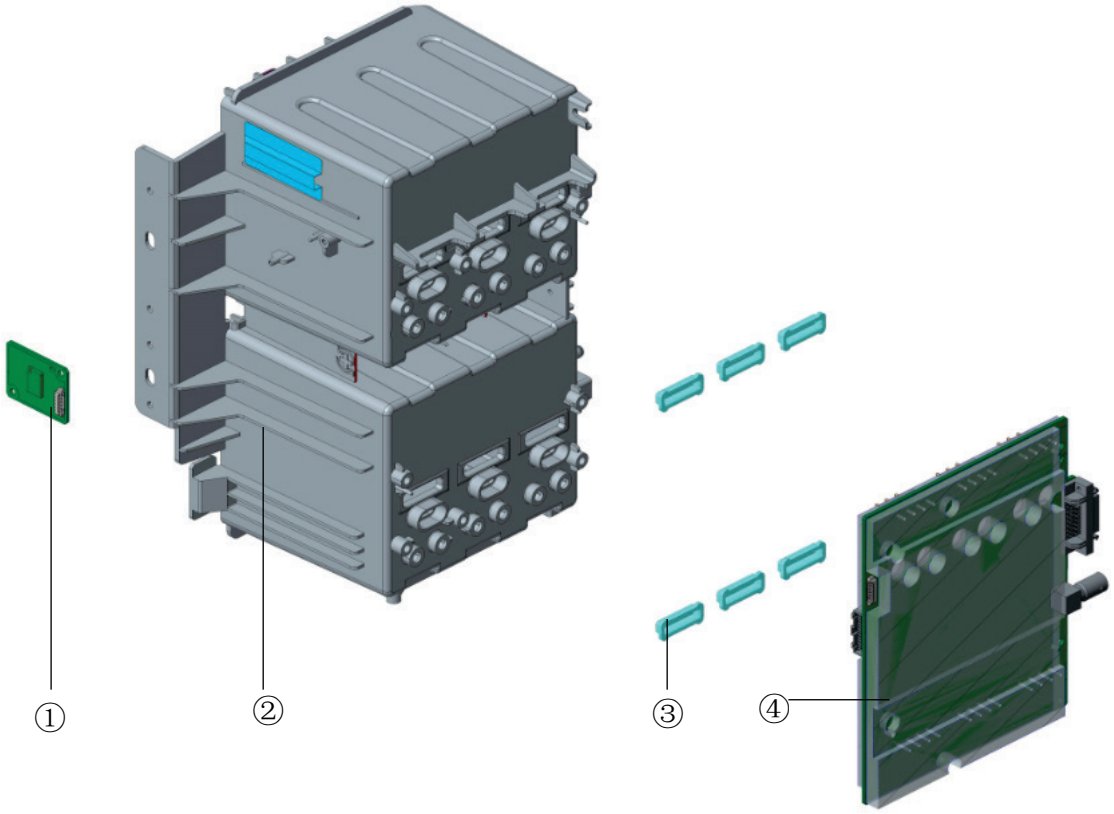


8.8.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	/	N15 internal module rack assembly	1	Refer to 1.9 N15/M15 Internal Module Rack Assembly
2	115-044547-00	N15N17 Speaker assembly(FRU)	1	/
3	115-044541-00	N15 rear housing assembly(FRU)	1	/
4	115-044542-00	N15 handle assembly(FRU)	1	/
5	043-007566-01	N15 Top cover（ESM）	1	/
6	043-008499-00	Recorder cover plate(ESM)	1	/
7	/	N15 main bracket assembly	1	Refer to 1.10 N15/M15 Main Bracket Assembly

8.9 N15/M15 Internal Module Rack Assembly

8.9.1 Exploded View

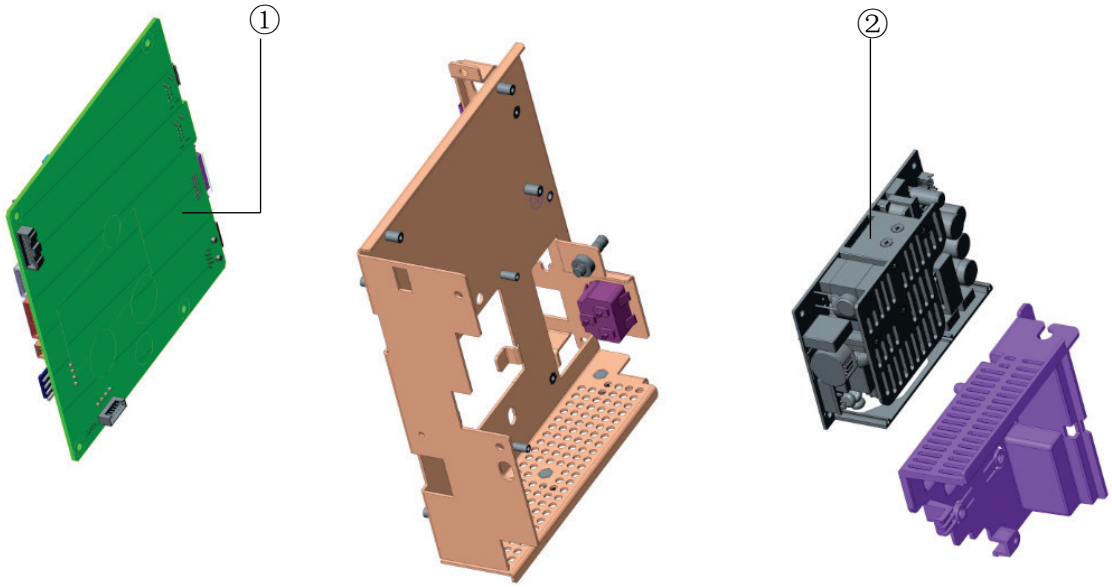


8.9.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	051-002738-00-00	MPAN carrier Board (FRU)	1	/
2	115-044546-00	N15N17 Service kit of Module Rack(FRU)	1	Infrared liens and contact screw parts number please refer to 1.19 Others
3	049-001230-00	pogo pin cover	6	/
4	051-002734-01-00	6-Slot modular rack (FRU/3Pin_No TDS&BNC)	1	/
	051-002735-01-00	6-Slot modular rack (FRU/3Pin_TDS&BNC)		/

8.10 N15/M15 Main Bracket Assembly

8.10.1 Exploded View

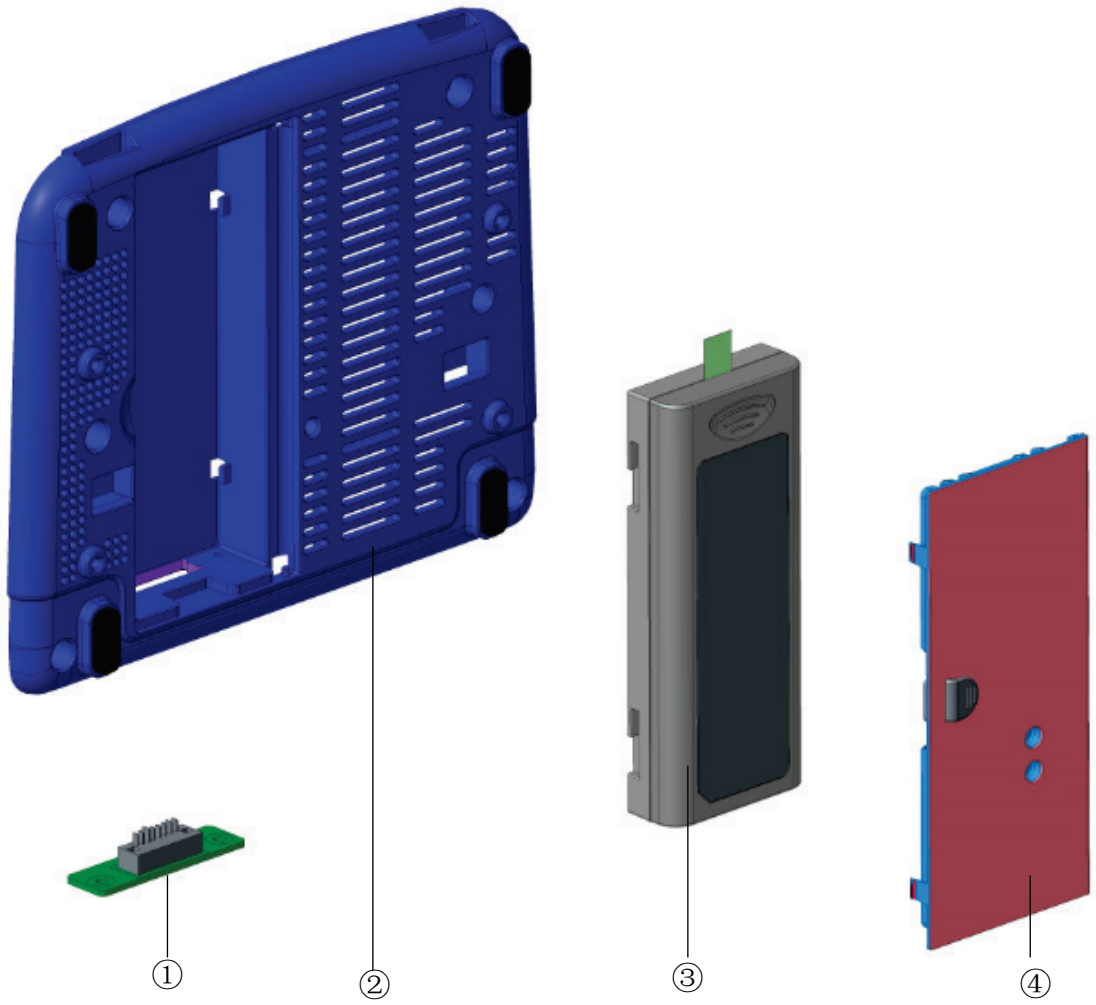


8.10.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-085682-00	N15 MainBoard PCBA (FRU/SW)	1	/
	115-085683-00	M15 MainBoard PCBA (FRU/SW)		/
2	022-000284-00	Power 100-240VAC 15V 100W	1	/

8.11 N15/M15 Bottom Housing

8.11.1 Exploded View

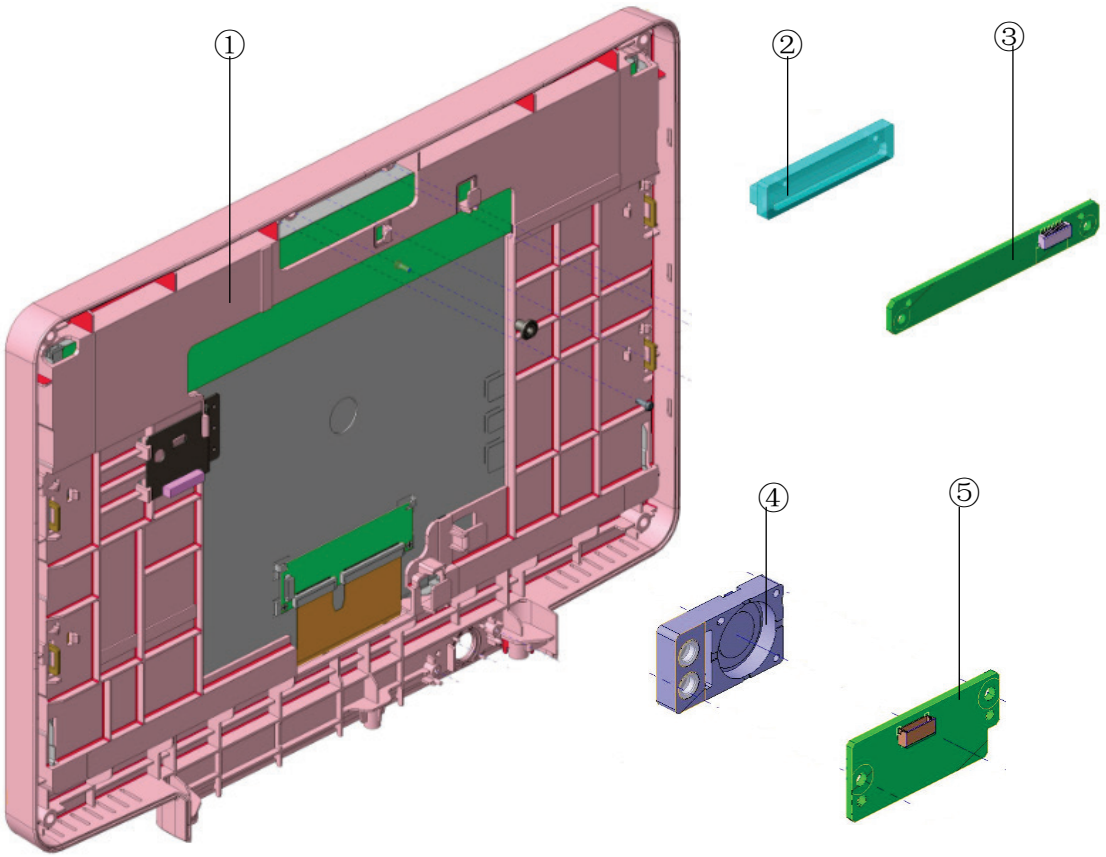


8.11.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	051-002723-00	Battery Interface Board PCBA	1	/
2	115-044543-00	N15 bottom housing assembly (FRU)	1	Include with 043-007966-00
3	115-065140-00	Li-ion Bat Pack (11.1V4500mAh LI23S002A)	1	/
4	043-007966-00	N15 Battery Door(with connective band)	1	/

8.12 N17/M17 Front Housing View

8.12.1 Exploded View

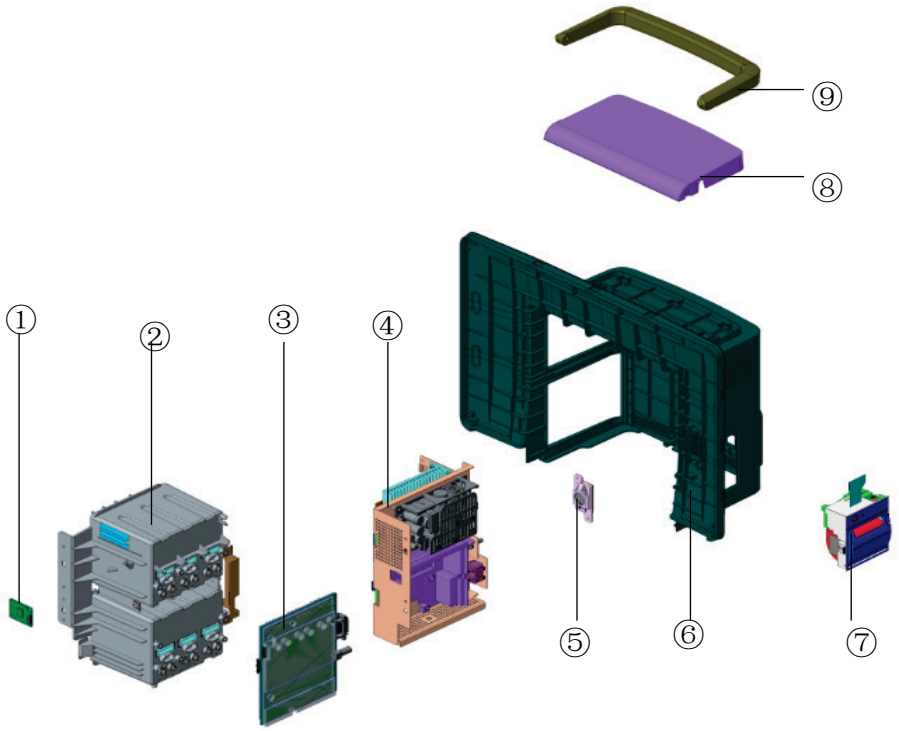


8.12.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-044551-00	N17-NLT front housing assembly (FRU)	1	Compatible with 115-044552-00
2	049-001135-00	MK alarm cap	1	/
3	051-002693-00	Alarm LED and Light Sensor Board PCBA	1	/
4	043-007956-01	MK POWER BUTTON(P+R)-ESM	1	/
5	051-002711-00	Power Switch and Indicate LED Board PCBA	1	/

8.13 N17/M17 Rear Housing View

8.13.1 Exploded View

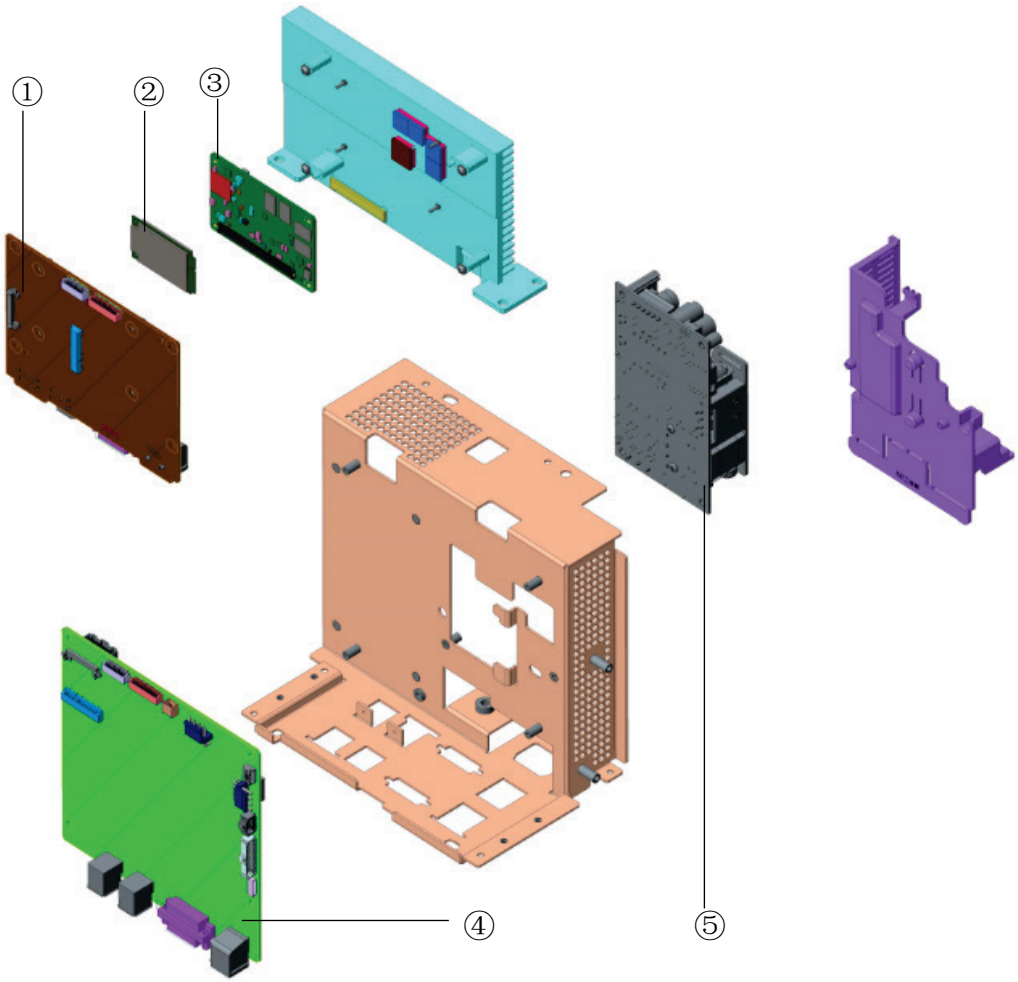


8.13.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	051-002738-00-00	MPAN carrier Board(FRU)	1	/
2	115-044546-00	N15N17 Service kit of Module Rack(FRU)	1	Infrared liens and contact screw parts number please refer to 1.19 Others
3	051-002735-01-00	6-Slot modular rack (FRU/3Pin_TDS&BNC)	1	/
4	/	N17 main bracket assembly	1	Refer to 1.14 N17/M17 Main Bracket Assembly
5	115-044547-00	N15N17 Speaker assembly(FRU)	1	/
6	115-044548-00	N17 rear housing assembly(FRU)	1	/
7	115-044523-00	Recorder upgrade package	1	Include with 6800-20-50301
8	043-007661-01	N17 Top cover-ESM	1	/
9	115-044549-00	N17 handle assembly(FRU)	1	/

8.14 N17/M17 Main Bracket Assembly

8.14.1 Exploded View



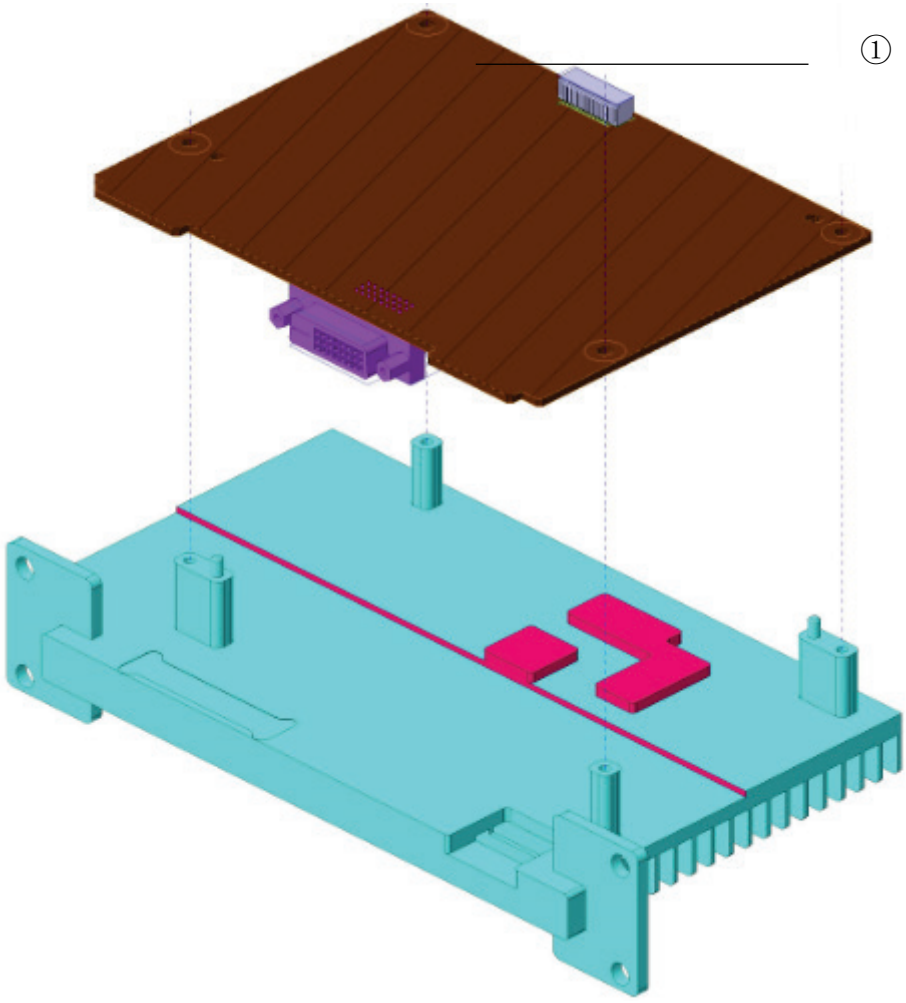
8.14.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	051-003029-00	iView Carrier Board PCBA	1	win10 system
2	023-001497-00	N4200 8GB COME Mini Type 10 (ODM)	1	win10 system
3	115-056281-00	iView module PCBA FRU	1	win10 system
4	115-085670-00	N17 Mainboard （FRU/SW<N17>/Standard：without iView&independent display）	1	/
	115-085672-00	N17 Mainboard （FRU/SW<N17>/Fully configured： with iView&independent display）		
	115-085671-00	M17 Mainboard		

No.	Order Number	Part Description	Qty	Remark
		（FRU/SW<M17>/Standard：without iView&independent display）		
	115-085673-00	M17 Mainboard （FRU/SW<M17>/Fully configured： with iView&independent display）		/
5	022-000284-00	Power 100-240VAC 15V 100W	1	/

8.15 N17/M17 Independent Display Assembly

8.15.1 Exploded View

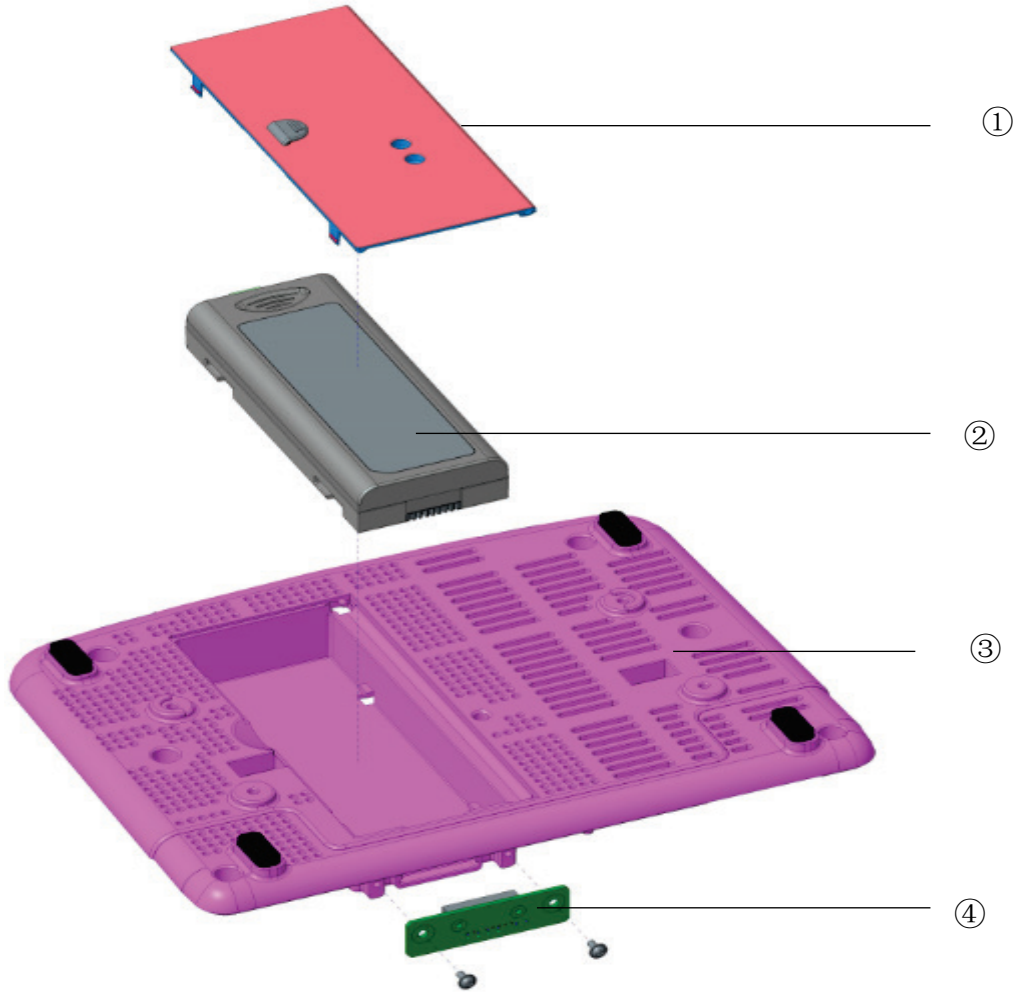


8.15.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	051-002712-00	Independent Display Board PCBA	1	/

8.16 N17/M17 Bottom Housing

8.16.1 Exploded View

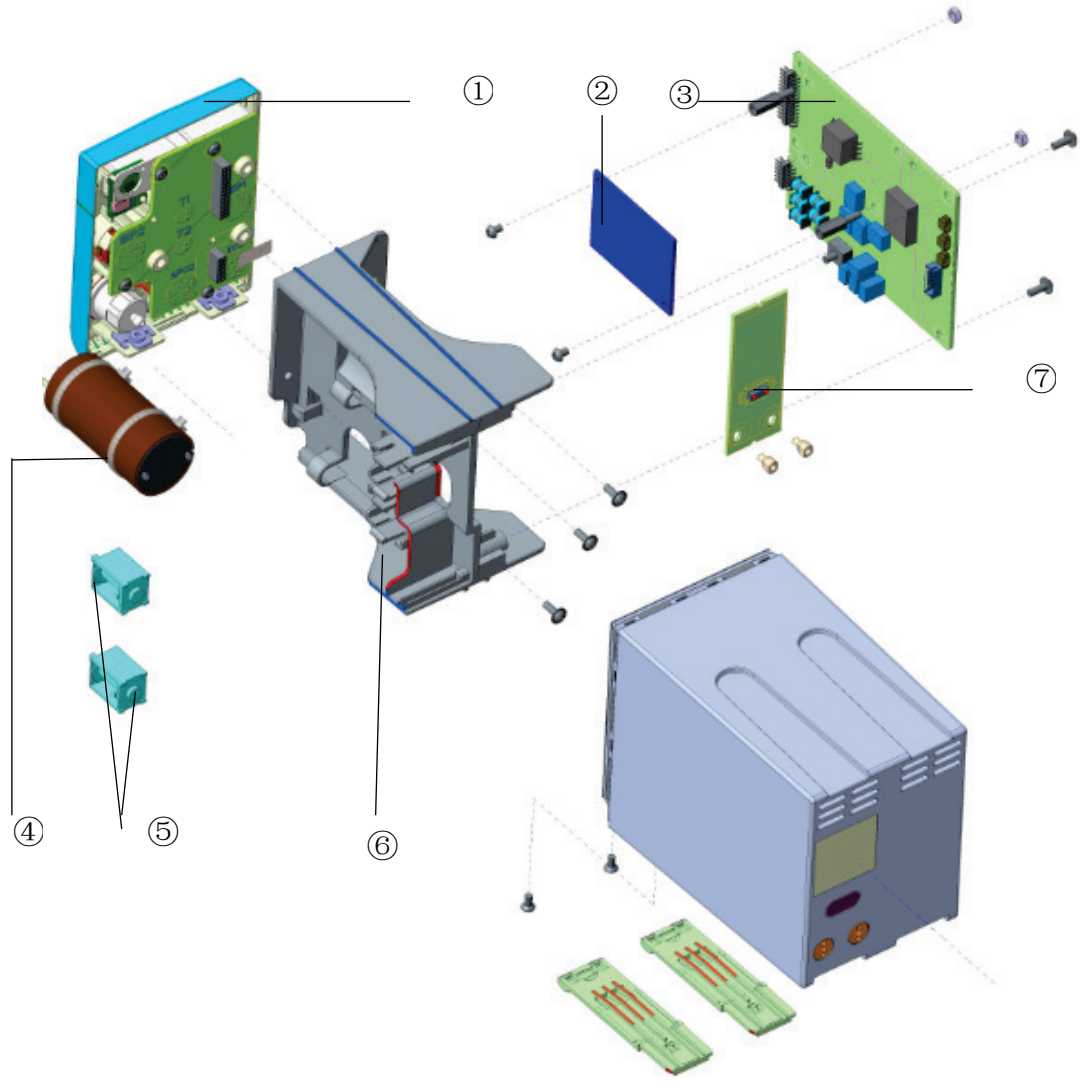


8.16.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	043-007966-00	N15 Battery Door(with connective band)	1	/
2	115-065140-00	Li-ion Bat Pack (11.1V4500mAh LI23S002A)	1	/
3	115-044550-00	N17 bottom housing assembly(FRU)	1	/
4	051-002723-00	Battery Interface Board PCBA	1	/

8.17 MPM module (M51A)

8.17.1 Exploded View



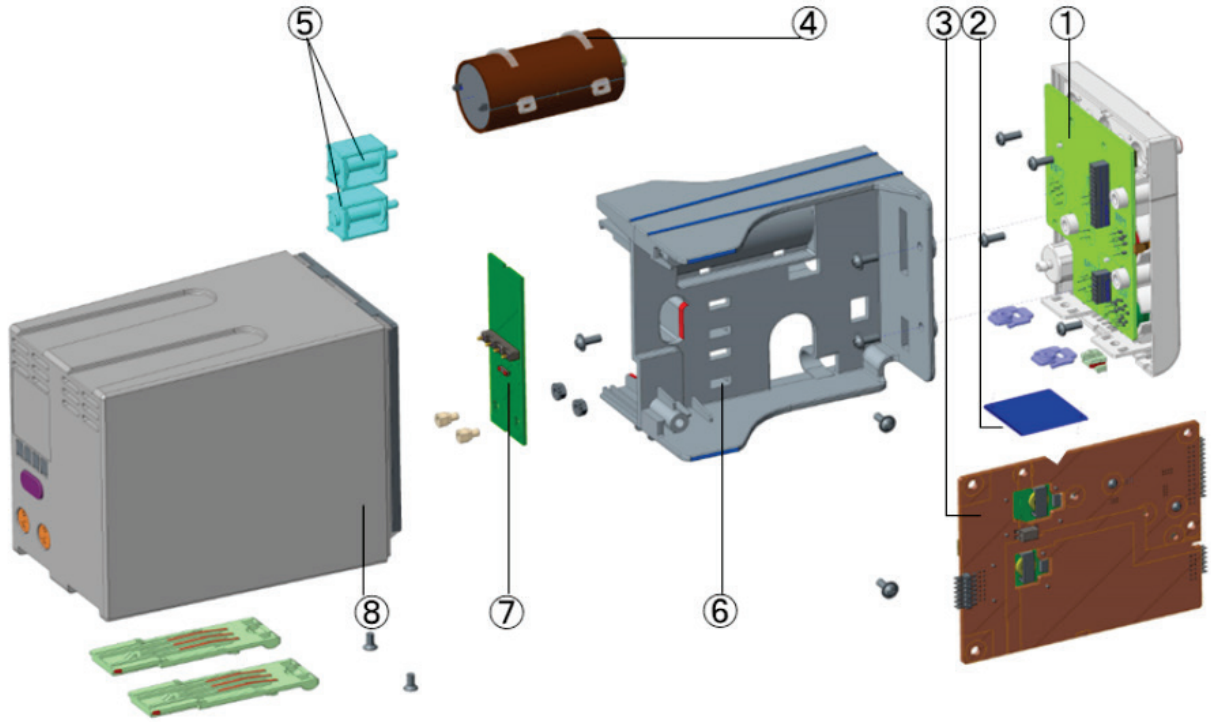
8.17.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-033839-00	New MPM front panel assembly (Mindray SPO_2/ analog output)	1	/
	115-033840-00	New MPM front panel assembly (Nellcor SPO_2/analog output)		/
2	051-000943-00	9008 V2.0 blood oxygen board PCBA	1	/
	100-000106-00	Nellcor blood oxygen board RoHS		/
	040-001149-01	Masimo MS-2013SB blood oxygen board (dedicated to Shenzhen product) RoHS		/
3	051-002039-00	MPM multi-parameter module (12 leads, 3rd standard CE) PCBA	1	/
	051-002232-00	M51A multi-parameter module (12 leads, analog	1	/

No.	Order Number	Part Description	Qty	Remark
		output) PCBA		
	051-002066-00	M51A Multi-Para module PCBA(5 std)(3rd std CE)	1	/
4	082-000862-00	Pump. 12VDC with 120 wire and connector	1	/
5	082-000864-00	Air valve. Dual air valve (custom) 12VDC normally-open line, 125 mm long	1	One material with two valves
6	043-001964-02	Bracket (T8)	1	/
7	115-034329-00	M51A Infrared communication board	1	/

8.18 M51C Module (Platinum)

8.18.1 Exploded View



8.18.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-044670-01	M51C front panel maintenance package (Mindray SpO2/IBP FRU)	1	/
	115-044671-01	M51C front panel maintenance package (Nellcor SpO2/IBP FRU)		/
	115-044672-01	M51C front panel maintenance package (Mindray /IBP analog FRU)		/
	115-044673-01	M51C front panel maintenance package (Nellcor /IBP analog FRU)		/

No.	Order Number	Part Description	Qty	Remark
	115-044668-01	M51C Front assembly(Mindray SpO2/No IBP)		/
	115-044669-01	M51C Front assembly(Nellcor SpO2/No IBP)		/
2	051-002353-00	M51C-9008V3.0 SPO2 PCBA	1	/
	101-000469-00	Nellcor SpO2 PCBA		/
3	051-002481-01	M51C Parameter board(5 lead/MR SpO2/no IBP/with MPM connector)	1	Replace 051-002481-00
	051-002482-01	M51C-ME, 5L5P, MR/NC-SPO2, IBP, MPM I/F		Replace 051-002482-00
	051-002483-00-00	M51C Full configuration parameter board(extend ARR 12lead ST and Glasgow/FRU)		/
	051-002483-00-01	M51C Full configuration parameter board(Mindray:Hr +Glasgow_12/FRU)		/
4	082-000862-00	Pump. 12VDC with 120 wire and connector	1	/
5	082-000864-00	Air valve. Dual air valve (custom) 12VDC normally-open line, 125 mm long	1	One material with two valves
6	043-001964-02	Bracket (T8)	1	/
7	051-002383-00-00	M51C module back plane (with IBP/FRU)	1	/
	051-002383-00-01	M51C module communication backplane（no IBP）		/
8	115-044674-00	M51C rear housing assembly(FRU)	1	/

8.19 Others

No.	Order Number	Part Description	Qty	Remark
1	049-001214-00	MK hood	1	Alarm lamp parts
2	043-007582-00	light pipe	1	Alarm lamp parts
3	047-005213-00	infrared lens	1	Modular rack parts
4	6800-20-50388	Spring	1	Modular rack parts
5	6800-21-51100	Contact screw	1	Modular rack parts
6	6800-20-50261	Contact spring	1	Modular rack parts
7	9211-20-87369	AC Inlet Hook	1	others
8	049-001210-00	N17 screw cover	1	others
9	043-007643-00	Recorder Spacer Plate	1	Recorder parts
10	043-008529-00	Recorder door (ESM)	1	Recorder parts
11	115-033940-01	TR6F Recorder(ESM)	1	Recorder parts

No.	Order Number	Part Description	Qty	Remark
12	6800-20-50301	Recorder to main board connection line	1	Recorder parts
13	051-002330-00	Carrier Board of Wireless Module(PCBA)	/	Wifi parts
14	024-000707-00	WIFI module support IEEE 802.11a/b/g/n	/	Wifi parts
15	024-000751-00	Embedded Wireless Antenna	/	Wifi parts
16	047-006112-00	9281 WIFI antenna label	/	Wifi parts
17	009-006735-00	N12N15N17 MPAN board connection line	/	MPAN parts
18	024-000718-00	2.4GHz Antenna For MPAN	/	MPAN parts
19	047-015467-00	BT antenna tabs	/	MPAN parts
20	115-050029-00	U disk for iView Ghost（Win10）	/	others
21	115-044675-00	M51C tube accessory(FRU)	/	M51C parts
22	009-001770-00	RJ45 connecting cable	/	others
23	115-044521-00	2.4G/5G Wifi upgrade package	1	Upgrade package
24	115-044522-00	MPAN upgrade package	1	Upgrade package
25	115-050002-00	iView upgrade package（without main board /Win 10）	1	For N17
26	115-044554-00	Independent display upgrade package(Without Main Board)	1	For N17
27	115-044579-00	Independent display upgrade package(Main Board)	1	For N17
28	115-044508-00	Upgrade package(DVI&TDS&BNC)	1	For N12
29	115-049179-00	MPM-IBP Upgrade Kit(NC SPO2 3/5 lead)	1	Upgrade package
30	115-049180-00	MPM-IBP Upgrade Kit(MR SPO2 3/5 lead)	1	Upgrade package

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 cannot 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 cannot 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 cannot 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:_____

P/N: 046-010023-00(7.0)