BeneVision N22/N19

Patient Monitor

Service Manual

Intellectual Property Statement

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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: 8.0
- Release time: 2021-03

Preface

Manual Purpose

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

Intended Audience

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

Passwords

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

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

Contents

1 Safety

1.1 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.

FOR YOUR NOTES

2 Operation Theory

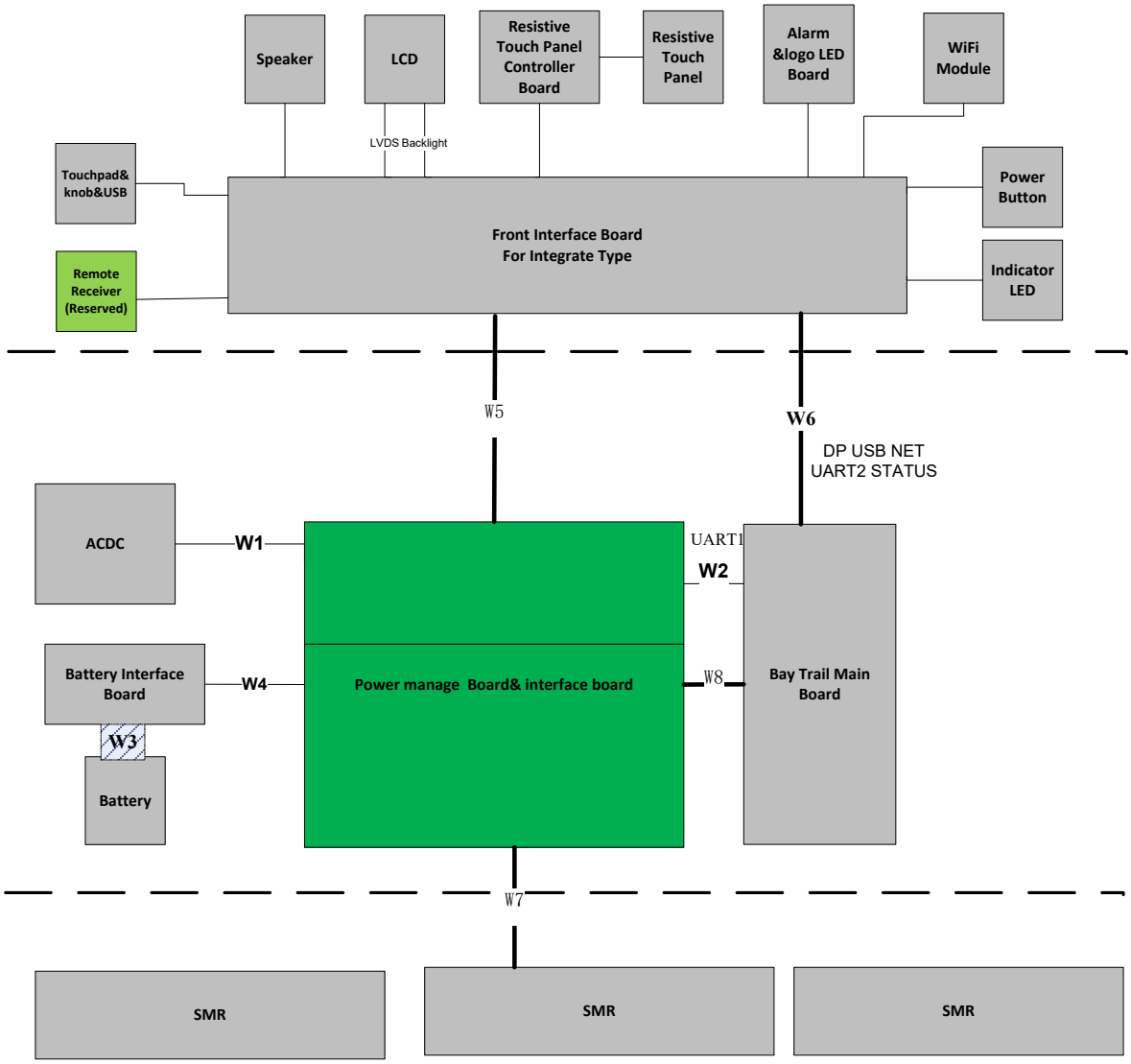
2.1 Overview

TheN22/N19 patient monitor provides rich functionality to monitor patient's vital signs including ECG, Resp, SpO_2, Temp, NIBP, IBP, CO_2, AG, O_2, RM, C.O., CCO, ICG, SvO_2/$ScvO_2$, BIS, EEG, NMT, tcGas and rSO_2. Based on these parameters, the monitor supports alarm management, data review, recording and printing of patient reports, and calculation. TheN22/N19 patient monitor is applicable to various departments in a hospital, in particular, to the applications in intensive care, first aid, operation room and the relevant departments.

The N22/N19patient monitor provides clinical decision-making tools to assist the medical personnel in making diagnosis and clinical judgment faster and more accurately. Information access to clinical information system can meet the information requirements of doctors and nurses so as to shorten the time of obtaining information and analyze the clinical experience. These features could better meet the application requirements of high-end users.

2.2 Product System Architecture

N22/N19 monitor mainly consists of three parts: main unit, display and module rack. All-in-one installation or split-type installation could be adopted for the main unit and the display.



The main PCBAs of the system include:

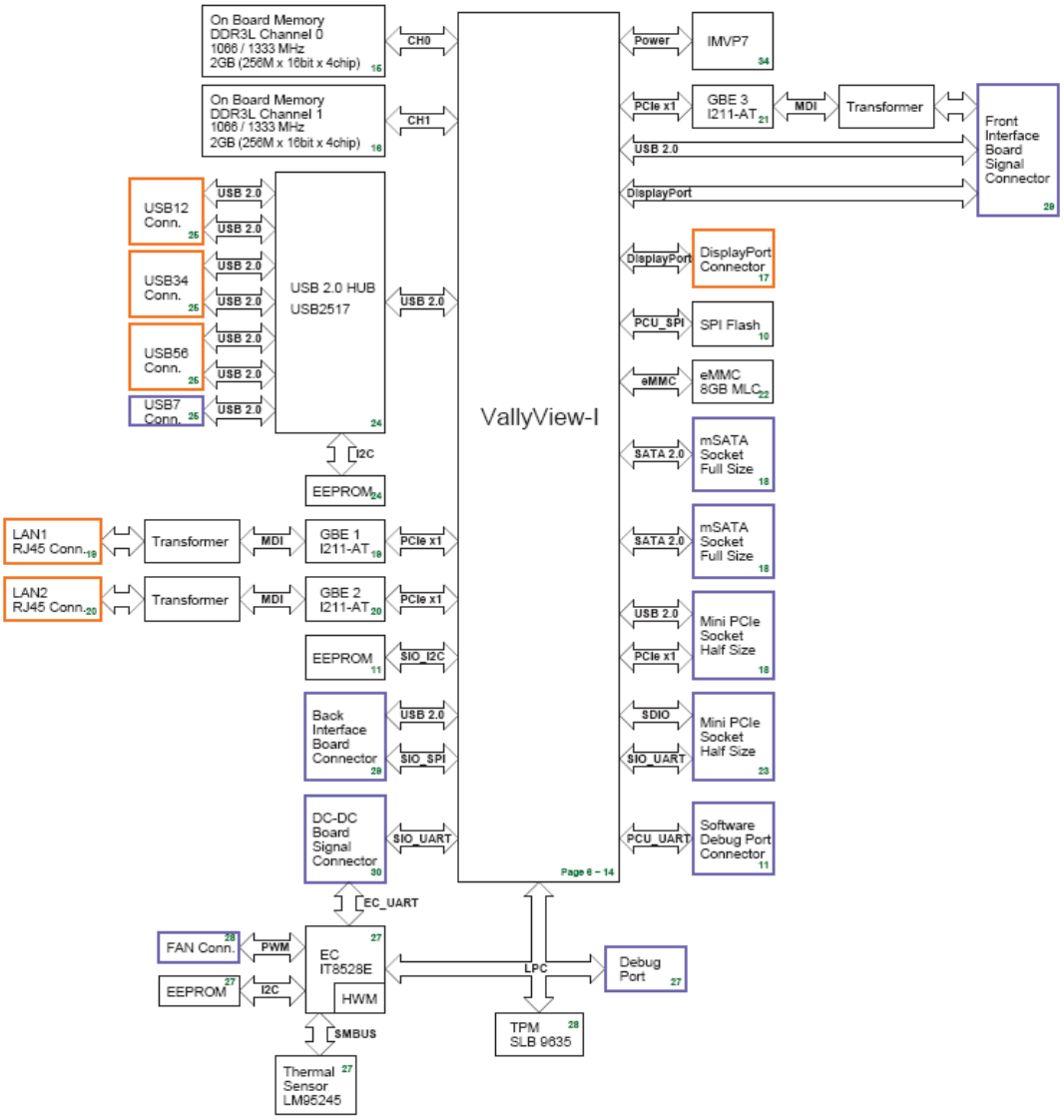
Main unit: DCDC and interface board, ACDC board, and main board and interface board.

Display: display interface board

Module rack: Module rack interface board, and 8-slot module rack communication board.

2.2.1 Functions of the Main Control Module

The main board is supported by the Bay Trail platform and uses Intel's Bay Trail-I E38xx series processors.



Architecture of the Main Board

As the core control unit of the system, the main board is responsible for such core functions of the system as display, data processing and data storage.

The main board also provides high-speed interfaces, such as USB connector, DP interface and network connector.

2.2.2 AC-DC Module

The ACDC module converts the input voltage of 100~240V 50/60Hz AC into the output of 16V 10A DC.

2.2.3 Functions and Socket Definitions of the DCDC Board

2.2.3.1 Functions of the DCDC Board

On the one hand, the DCDC board is responsible for the conversion of the data signal of the main board into the external interface; on the other hand, the DCDC board is responsible for generating the DCDC power supply of the hardware system and for implementing the power management function. The major functions include:

- Generation and management of 12V, 5V, 3.3V, Vbus and 3.3VB power supply required for the system operation;
- Extension of connectors such as SMR;
- Monitor startup and shutdown;
- Battery management;

2.2.3.2 Definitions of the DCDC Board Socket

The DCDC board is the core for connecting other PCBAs inside the main unit, and the main sockets include:

16V DC input power socket used for connecting to the ACDC board

Connector Type	**B6PH-VS**			
Pin No.	**Signal Name**	**Signal Direction**	**Function Definition**	**Remarks**
1	16V	IN	DC input	/
2	16V	IN	DC input	/
3	16V	IN	DC input	/
4	GND	/	Ground	/
5	GND	/	Ground	/
6	GND	/	Ground	/

Power connector of the battery interface board

Used for connecting the charging and discharging power of the battery interface board.

Connector Type	**B4PS-VH**			
Pin No.	**Signal Name**	**Signal Direction**	**Function Definition**	**Remarks**
1	GND	/	Ground	/
2	BAT	BI	Battery power	/
3	BAT	BI	Battery power	/
4	GND	/	Ground	/

Signal connector of the battery interface board

Used for connecting the battery availability signal and SMB signal of the battery interface board.

Connector Type	B3B-PH-K-S			
Pin No.	**Signal Name**	**Signal Direction**	**Function Definition**	**Remarks**
1	BAT_BC	IN	Battery availability signal	/
2	SMB_D	BI	SMBus data signal	/
3	SMB_C	OUT	SMBus clock signal	/

Power connector of the main board

Used for connecting the main board to provide 3.3V, 5V and 16V DC power to the main board.

Connector Type	43045-0800			
Pin No.	**Signal Name**	**Signal Direction**	**Function Definition**	**Remarks**
1	3.3V	OUT	DC output	/
2	5V	OUT	DC output	/
3	5V	OUT	DC output	/
4	16V	OUT	DC output	/
5	GND	/	Ground	/
6	GND	/	Ground	/
7	GND	/	Ground	/
8	GND	/	Ground	/

Signal connector of the main board

Used for connecting the main board, including SPI, USB, UART, reset, power indicator and management signals.

Connector Type	5015714007			
Pin No.	**Signal Name**	**Signal Direction**	**Function Definition**	**Remarks**
1	GND	/	Ground	/
2	GND	/	Ground	/
3	USB_DP	BI	USB D+	/
4	SPI_LVDS_CLKP	IN	SPI differential clock	Reserved
5	USB_DM	BI	USB D-	/
6	SPI_LVDS_CLKP	IN	SPI differential clock	Reserved
7	GND	/	Ground	/
8	GND	/	Ground	/
9	USB_Hub_RST#	IN	USB Hub reset	/
10	SPI_CLK	IN	SPI clock	/
11	FPGA_RST#	IN	FPGA reset	/
12	GND	/	Ground	/

Connector Type	5015714007			
Pin No.	**Signal Name**	**Signal Direction**	**Function Definition**	**Remarks**
13	NC	/	No signal connection	/
14	SPI_MOSI	IN	Primary output of SPI	/
15	NC	/	No signal connection	/
16	GND	/	Ground	/
17	NC	/	No signal connection	/
18	SPI_MISO	OUT	Secondary output of SPI	/
19	NC	/	No signal connection	/
20	GND	/	Ground	/
21	GND	/	Ground	/
22	SPI_CS#	IN	SPI chip select	/
23	EC_S3#	IN	S3 power status	/
24	SPI_CTL1	IN	GPI	/
25	EC_S4#	IN	S4 power Status	/
26	SPI_CTL2	OUT	GPO	/
27	PLTRST#_Report	IN	CPU reset status	/
28	EC_RST#_Report	IN	EC reset status	/
29	AC_BC	OUT	AC availability	/
30	GND	/	Ground	/
31	Battery_Yellow	OUT	Battery driven by yellow LED	/
32	M0_TXD	OUT	M0 UART sending	/
33	Battery_Green	OUT	Battery driven by green LED	/
34	M0_RXD	IN	M0 UART receiving	/
35	PWROK	OUT	Power supply status	/
36	NC	/	No signal connection	/
37	PWR_BTN#	OUT	Main control startup and shutdown	/
38	NC	/	No signal connection	/
39	GND	/	Ground	/
40	GND	/	Ground	/

DC power output connector of the main unit

Used by the main unit for providing 12V power supply to the display.

Connector Type	43045-0409			
Pin No.	**Signal Name**	**Signal Direction**	**Function Definition**	**Remarks**
1	12V	OUT	DC output	/
2	12V	OUT	DC output	Reserved
3	GND	/	Ground	Reserved
4	GND	/	Ground	/

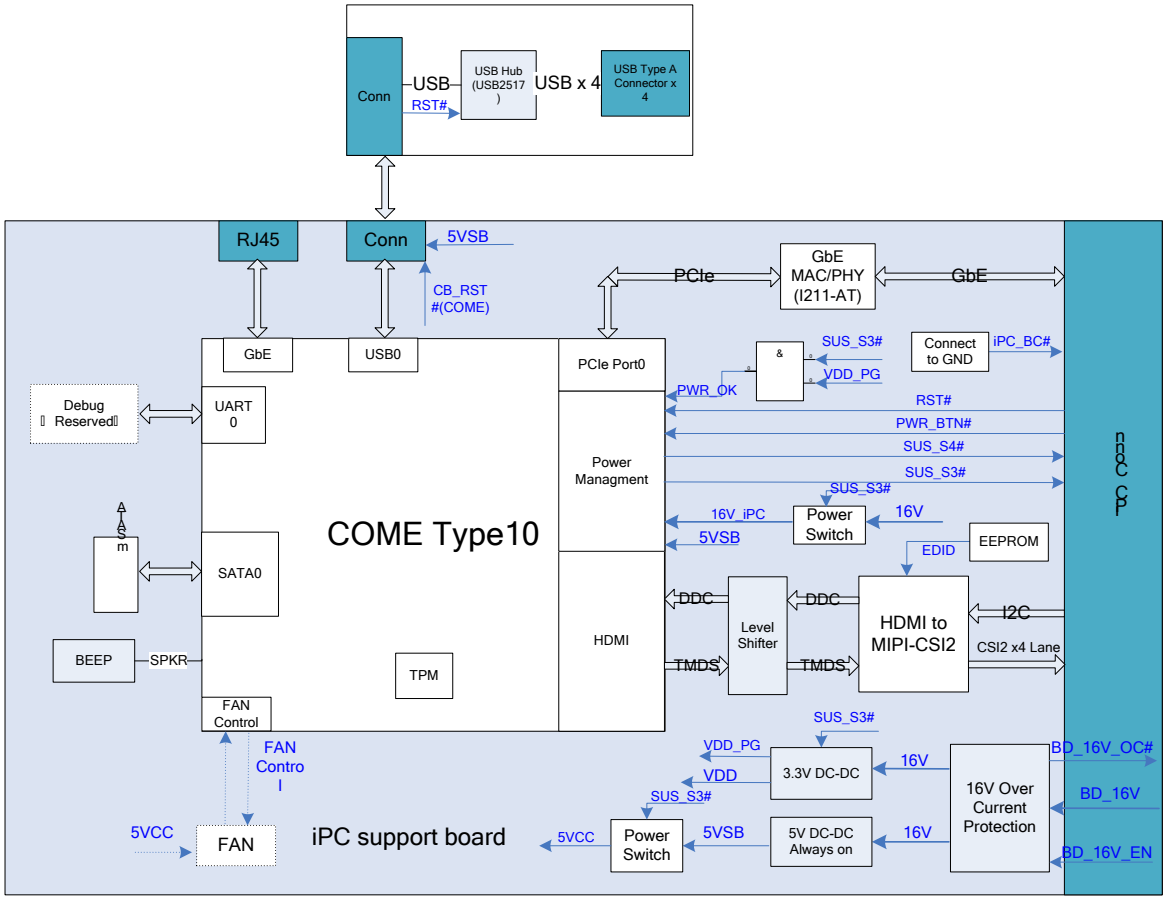
2.2.4 Front Housing Interface Board

The front housing interface board and its peripheral circuits are mainly used for realizing the control of the alarm LED, LOGO LED, backlight and audio, as well as the detection and transmission of the touchscreen, encoder and ambient light.

As the front housing has too much to control, a MCU is used for the central control. The MCP is connected to the main control of the system through DP AUX, and the USB connection channel is reserved.

2.2.5 iView Substrate

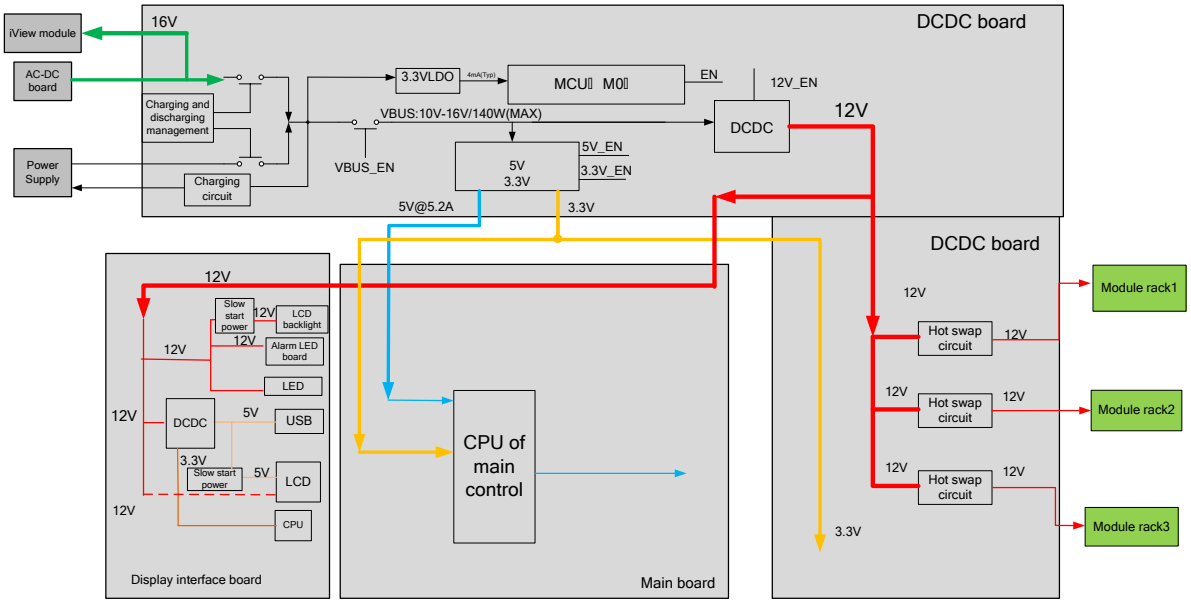
iView substrate is mainly used to carry the COME module, extending the function of the COME to standard interfaces as well as communication signals with the main board.



The COME module uses Type10 module (mechanical size: 55 mm x 84 mm) as defined in the specifications, and the connection with the main board could be realized with one 220pin socket.

2.3 Power System

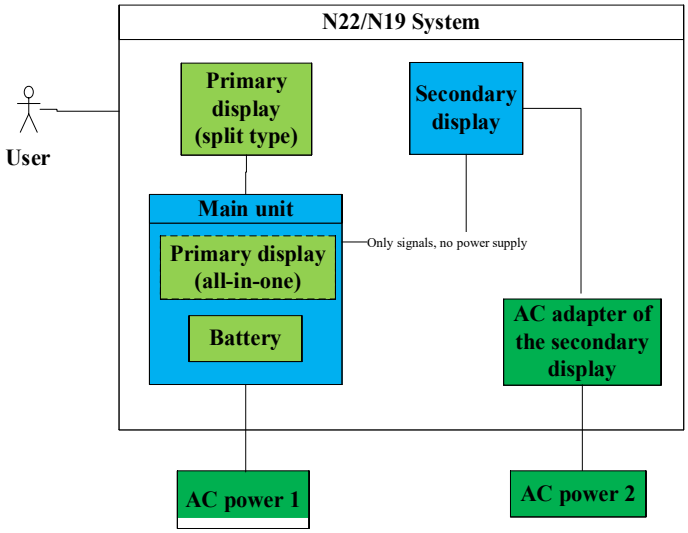
2.3.1 Power Diagram of the Main Unit and the Module Rack



The power management MCU is the core of the power management. In the system, 3.3V STB output could be realized with any power input (AC or battery), which means that the power management MCU works properly. The display interface board and module rack of the front housing could directly use the system's 12V power supply.

2.3.2 The Secondary Screen of N22/N19 Uses Independent AC Adapter for Power Supply

The connection is as shown below:



The battery is in the main unit, and the secondary screen is connected to the adapter. The startup and shutdown of the whole system cannot be implemented by controlling the secondary screen. Intelligent control of the switch of the secondary screen could realize the ON and OFF of the display of the secondary screen.

2.4 Signal Logic Flow

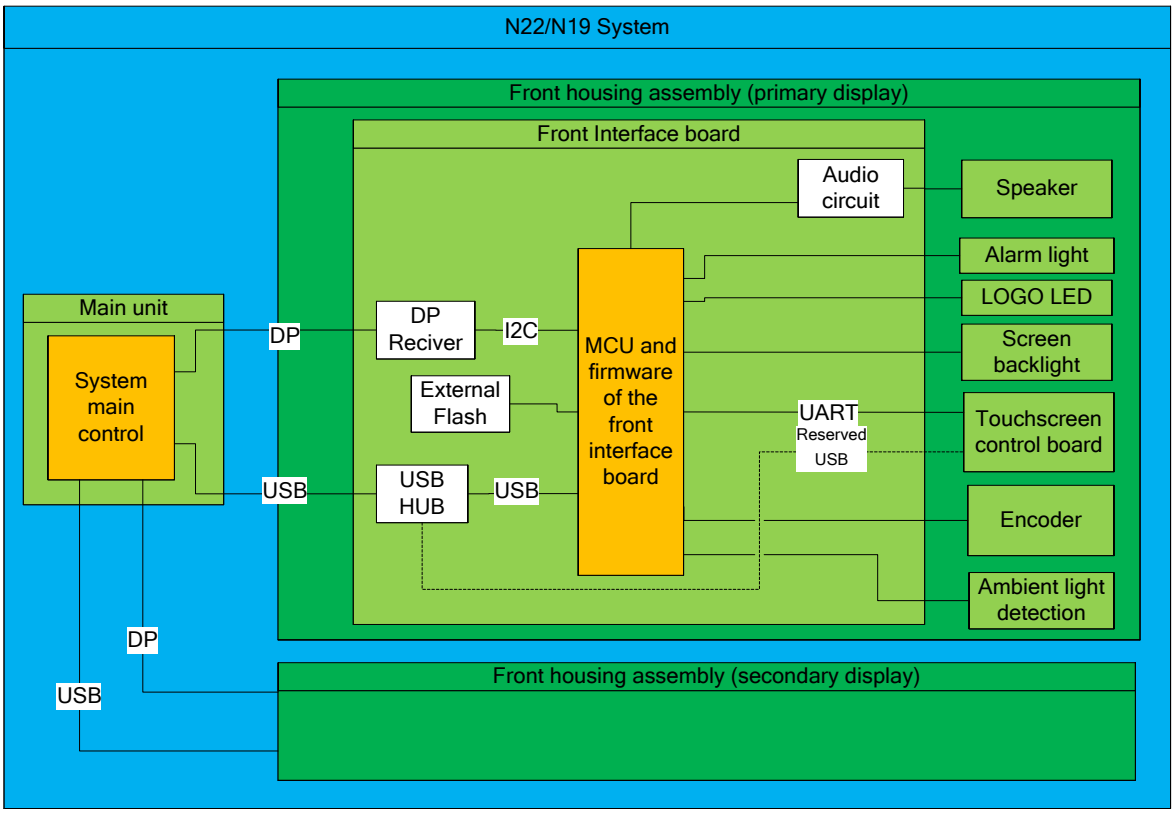
2.4.1 Startup Signal Flow

Major power-on process:

- Startup signal -> DCDC board power-on 12V, 3.3V, and 5V
- The main board operates based on the power-on sequence of the PC
- The main control enters BIOS, initializes peripherals of the main control, reads EDID and sets the display to ON
- The front housing enters the initialization state through the 12V power conversion
- The SMR enters the initialization state through the 12V power conversion
- Handshake would be implemented by the system after 40s, and the connection is established between the front housing, SMR, and the main control

Note: A power outage does not occur to the display with AC, even if compulsory power-on restart is carried out. Therefore, AC shall be removed for the complete reset of the system in case that batteries are available. After the AC is removed, press the button for more than 15s and the complete power-off of the system could be realized.

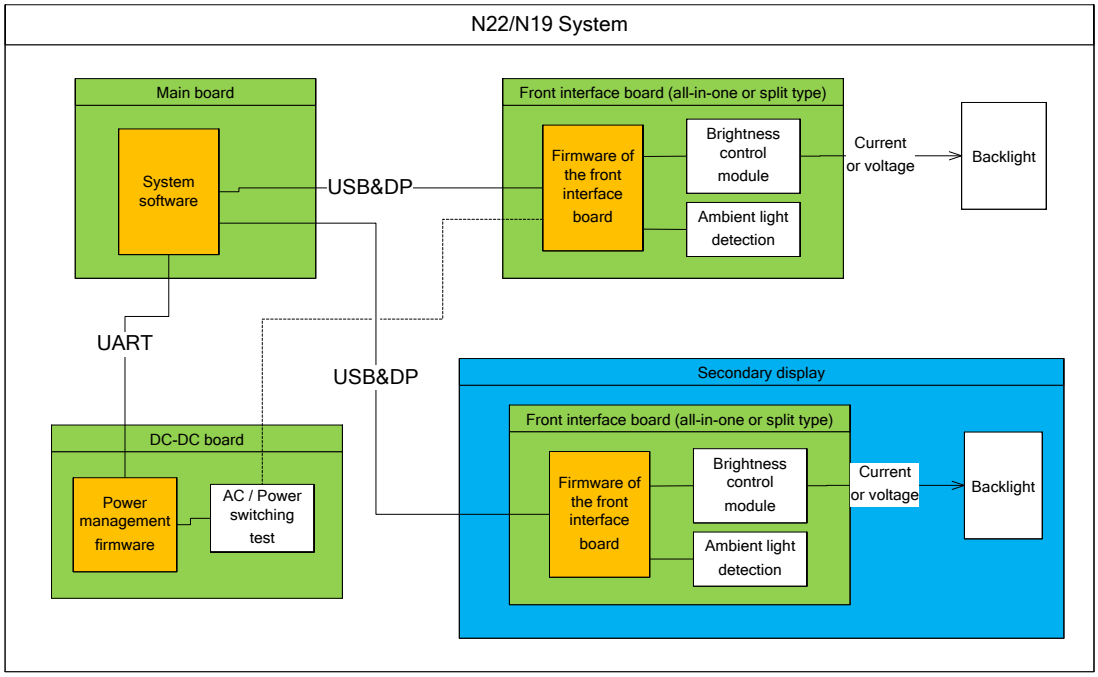
2.4.2 Display Signal Flow



The display function is implemented through the output of the main control, and it is realized through sending the signals to the front housing interface board through the DP interface. The front housing interface board converts the DP signals to LVDS signals through the DP conversion chip to drive the display.

2.4.3 Display Brightness Control

The physical architecture is as shown below:



As shown in the figure above, the dashed line indicates the fast hardware channel reserved for the AC battery switching event.

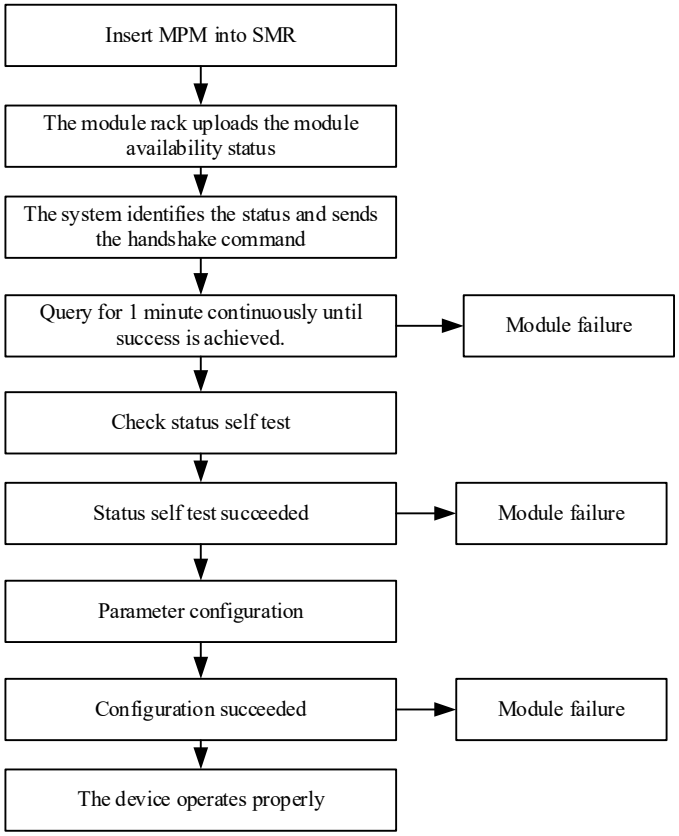
During operation, the system software adjusts the display brightness of the primary screen or secondary screen by directly sending command to the primary screen or secondary screen, and the CPU within the primary screen or secondary screen adjusts the backlight accordingly.

When using AC power supply, the main unit automatically identifies the power switch if the power switches to the battery in case of sudden AC power off. The main unit sends command to the primary screen, and the brightness of the primary screen is set down automatically.

2.4.4 Module Initialization

Parameter module power-on sequence:

Power-on description using MPM or T1 as an example:



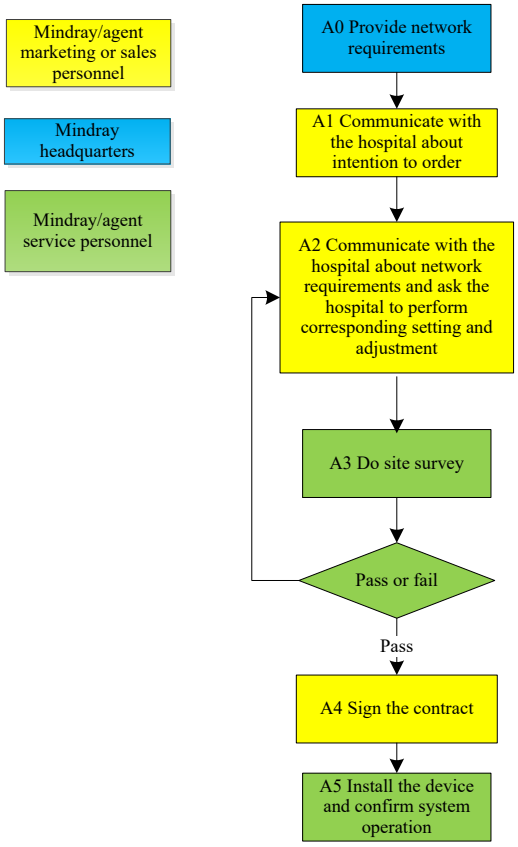
3 WLAN Installation

3.1 Introduction

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

3.2 Network Deployment Process

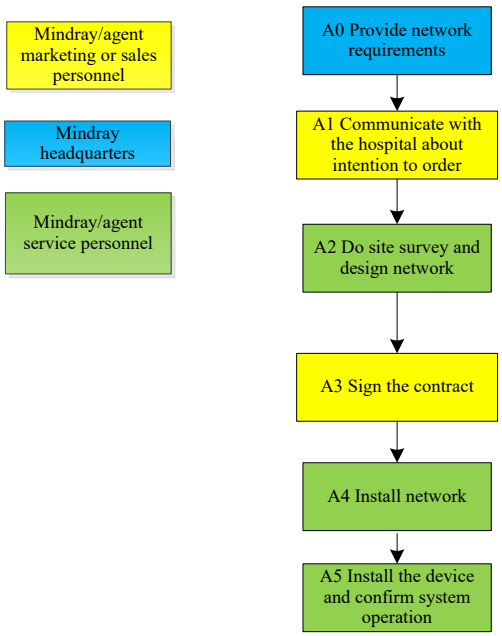
If the hospital has built its WLAN, the installation process is illustrated as follows:



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 wifi 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	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.
2	Device density	The maximum number of devices connected to one AP simultaneously is 12 (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	The WLAN cannot use safe modes not supported by the Mindray patient monitor. 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.
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	Multicast	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 wifi network SSID broadcast needs to be enabled to ensure that the wifi 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 wifi 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 wifi 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				
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 16 (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	The WLAN cannot use safe modes not supported by the Mindray patient monitor. 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	Check with hospital IT if this requirement is met or not.	

		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.	Check with hospital IT if this requirement is met or not.	
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.
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.
	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.

Symptom	Possible Cause	Recommended Measure
	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 usingnetwork survey tool and remove obvious interference sources or adjust WLAN deployment to meet the requirements of Mindray.

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)

Visual inspection

NIBP tests

CO_2 test and calibration

AG test and calibration

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="6">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>
<tr><td rowspan="2">AG tests</td><td>Performance test</td></tr>
<tr><td>Calibration</td></tr>
<tr><td colspan="3">Performance Tests</td></tr>
<tr><td rowspan="2">ECG tests</td><td>Performance test</td><td rowspan="25">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>Calibration</td></tr>
<tr><td colspan="2">Resp performance test</td></tr>
<tr><td colspan="2">SpO_2 test</td></tr>
<tr><td rowspan="2">NIBP test</td><td>Pressure check</td></tr>
<tr><td>Leakage test</td></tr>
<tr><td colspan="2">Temp test</td></tr>
<tr><td rowspan="2">IBP tests</td><td>Performance test</td></tr>
<tr><td>Pressure calibration</td></tr>
<tr><td colspan="2">C.O. test</td></tr>
<tr><td colspan="2">Mainstream CO_2 test</td></tr>
<tr><td rowspan="3">Sidestream and Microstream CO_2 tests</td><td>Leakage test</td></tr>
<tr><td>Performance test</td></tr>
<tr><td>Calibration</td></tr>
<tr><td rowspan="3">AG tests</td><td>Leakage test</td></tr>
<tr><td>Performance test</td></tr>
<tr><td>Calibration</td></tr>
<tr><td colspan="2">EEG test</td></tr>
<tr><td colspan="2">BIS test</td></tr>
<tr><td colspan="2">RM test</td></tr>
<tr><td rowspan="2">CCO/SvO_2 tests</td><td>Interconnecting function</td></tr>
<tr><td>Output calibration</td></tr>
<tr><td rowspan="2">NMT tests</td><td>Performance test</td></tr>
<tr><td>Sensor check</td></tr>
<tr><td colspan="2">PiCCO test</td></tr>
<tr><td colspan="2">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="2">Analog output performance test</td></tr>
</table>

EEG (self-made) test		Once every two years.
ANI test		
Electrical Safety Tests		
Electrical safety tests	Earth impedance	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.
	Earth leakage test	
	Patient leakage current	
	Patient auxiliary current	
Other Tests		
Power on test		1. When first installed or reinstalled. 2. Following any maintenance or the replacement of any main unit parts.
Touchscreen calibration （resistive touchscreen）		1. When the touchscreen appears abnormal. 2. After the touchscreen is replaced.
Recorder check		Following any repair or replacement of the recorder.
Network print test		1. When first installed. 2. Whenever the printer is serviced or replaced.
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, and $ScvO_2$ modules, because the first two 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 knob 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

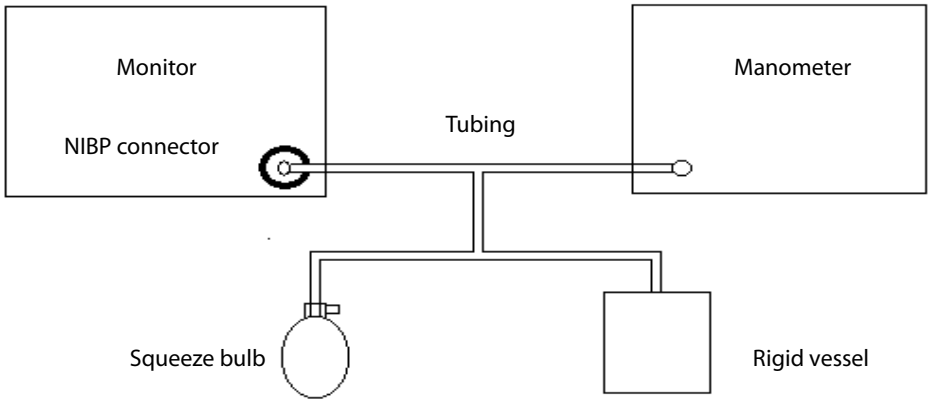
NIBP Accuracy Test

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.**

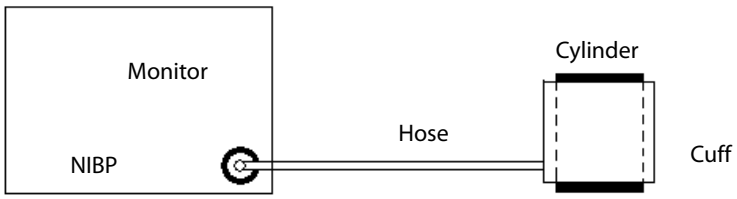
Leakage Test

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

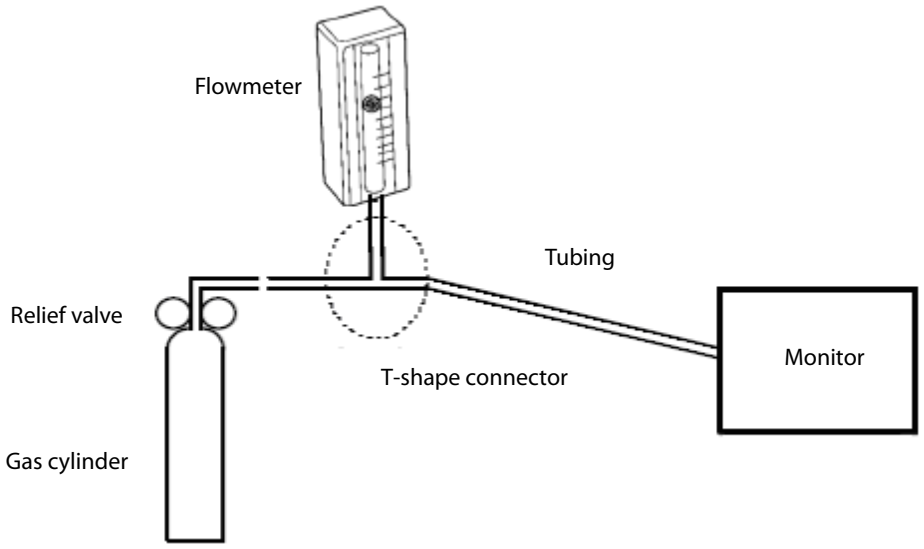
1. Plug the module into the module rack.
2. Wait until CO_2 warmup is finished and then completely block the gas inlet of the module or water trap (by using your finger or other objects). The sidestream and microstream CO_2 modules will behave as follows:
   - Sidestream: Plug the sidestream CO_2 module 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** → **CO_2** → **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** → **CO_2** → **Calibration**.
4. Connect the test system as follows:



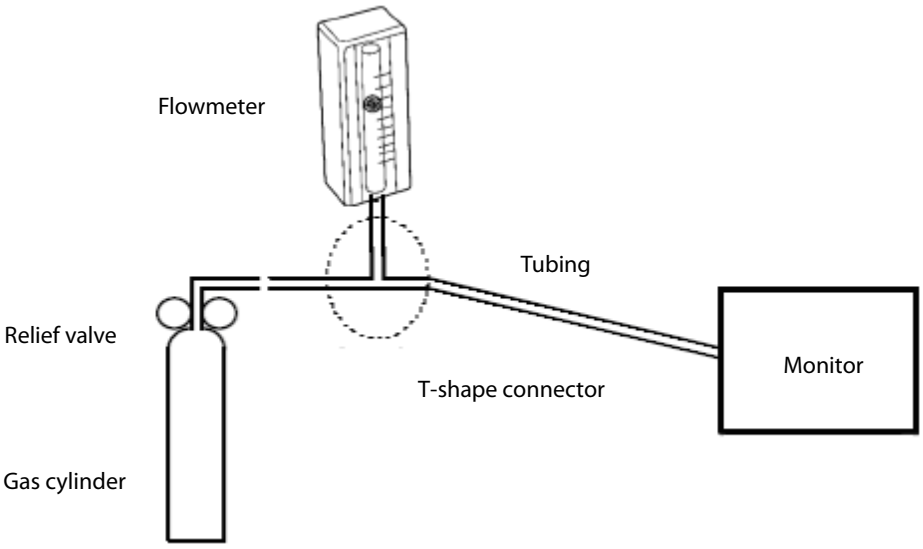
5. Open the relief valve, and adjust it until the flowmeter has a stable reading between 10 ml/min and 50 ml/min.
6. Check the real-time CO_2 value in the **Calibrate CO_2** menu and make sure the variation from the actual concentration is within ±0.2% (for microstream CO_2, the value is 45±2 mmHg).

Calibration

Tools required:w

- A steel gas cylinder withCO_2 (concentration range: 3%~7%) and balance gas N_2
- 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.

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.

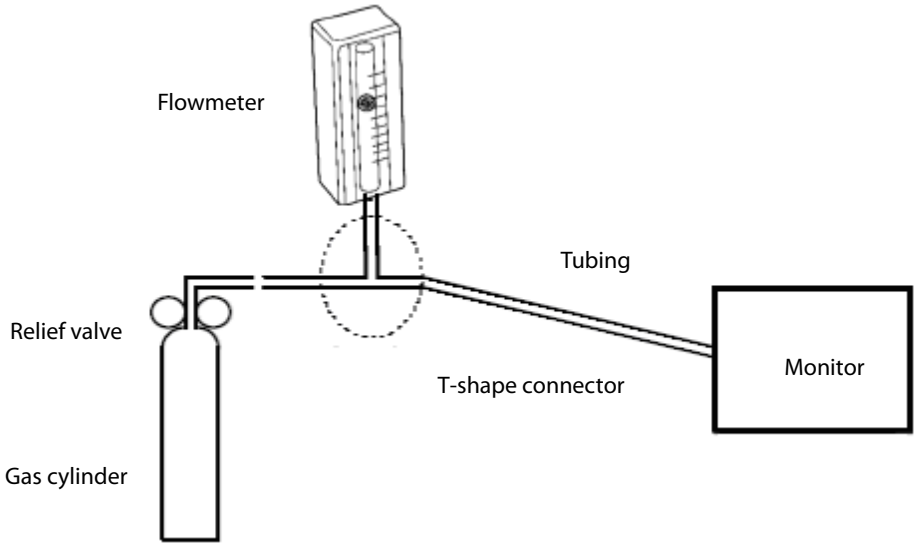
If the alarm message disappears, or the flow rate is greater than or equal to 10 ml/min, it indicates that the module leaks.

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.

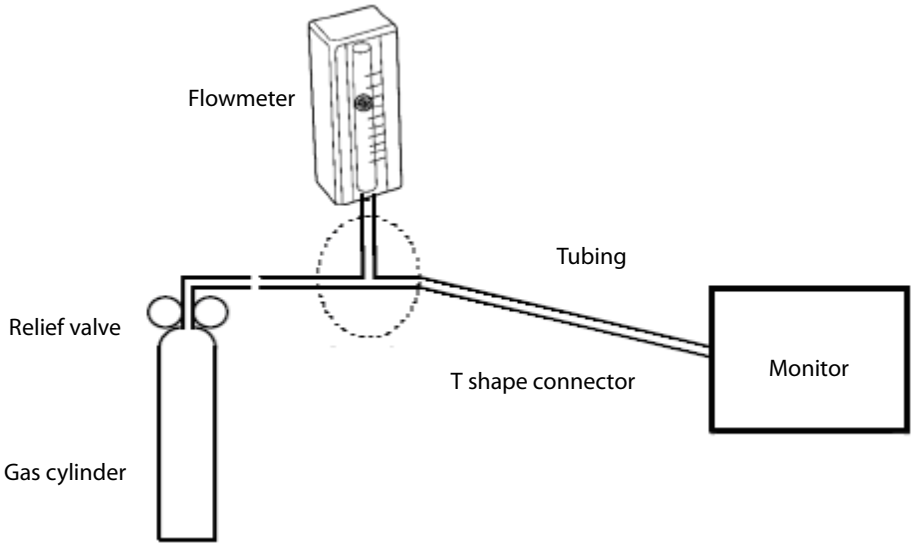
Calibration

Tools required:

- Gas cylinder with a certain standard gas (such as 6±0.05% 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 ≤ 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 anwd 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 sounds 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 ***4.4.4 NIBP 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 37°C).
3. Verify each Temp channel of the monitor and make sure that the displayed value is within 37±0.1°C.

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)

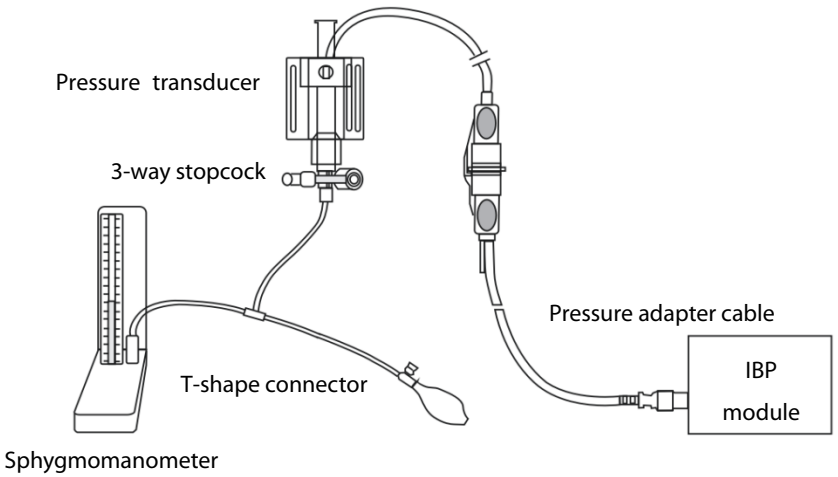
1. Connect the patient simulator to the monitor's IBP connector.
2. Set the patient simulator to 0 pressure for the desired IBP channel.
3. Press the **Zero** key on the module to make a zero calibration.
4. Set static pressure to 200 mmHg on the patient simulator.
5. Select **Main Menu** → **Maintenance** → 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

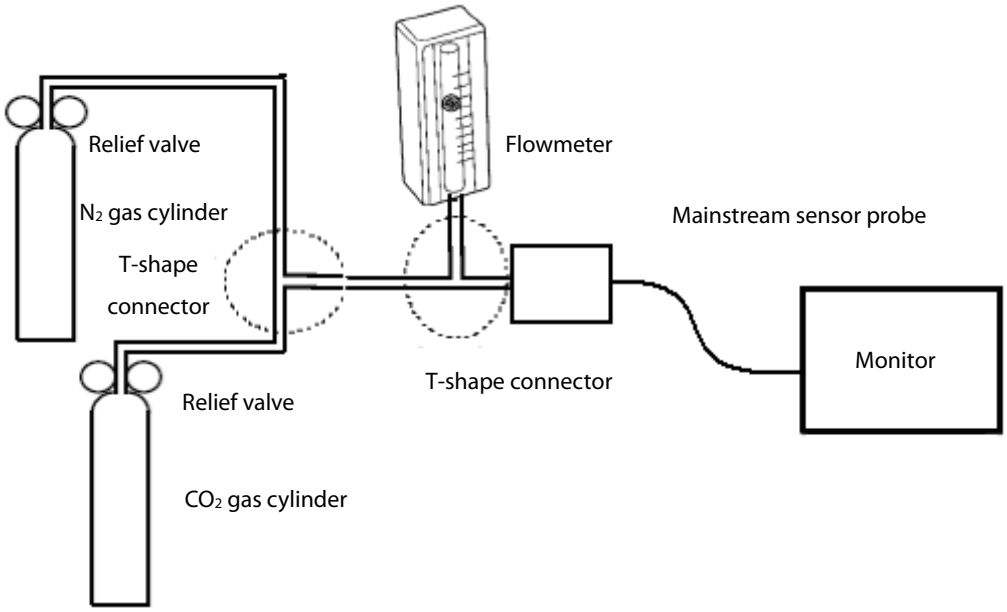
NOTE

- **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 **CO_2 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.

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

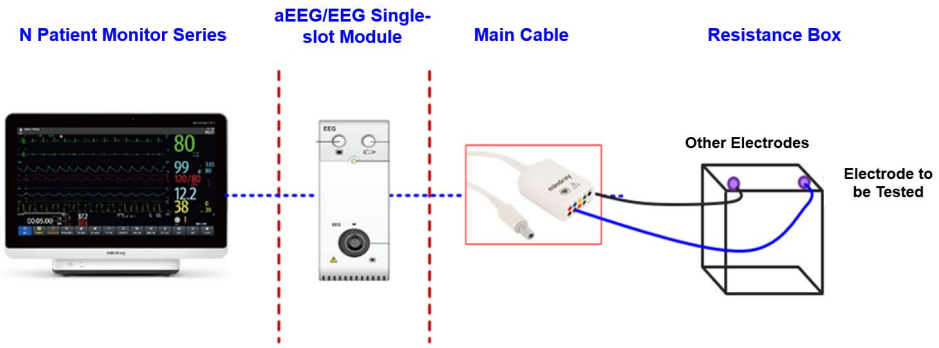
Connect all EEG leads together, for example, connect them to the same conducive metal object. Then, in the EEG module settings on the monitor, select impedance test. The electrode impedance is displayed. If the impedance of all leads is 0 or 1, the EEG module is functional.

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)

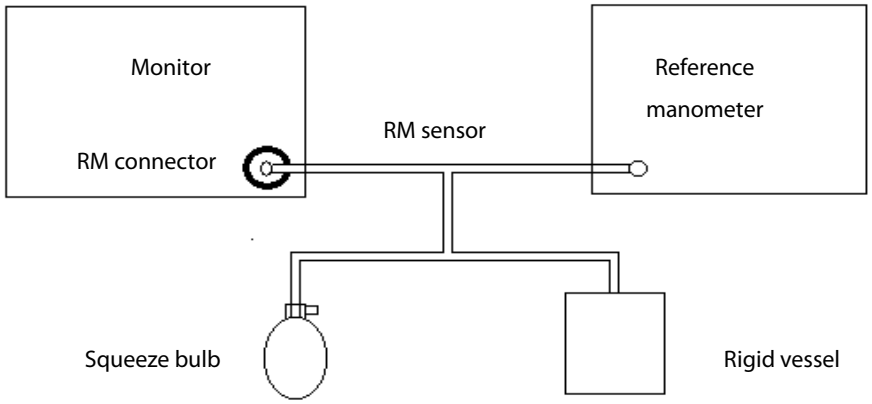
1. Connect the BIS sensor with the BIS simulator. Select BIS area parameter or waveform to access **BIS Setup**. Then, select **Sensor Check** to perform a cyclic impedance check.
2. After the cyclic impedance check is finished, check that the result for each electrode is passed.

4.4.13 RM 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)
- 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 60cmH2O, and check whether the RM airway pressure precision meets the requirement of 58.2~61.8cmH2O.



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
- 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
- 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.

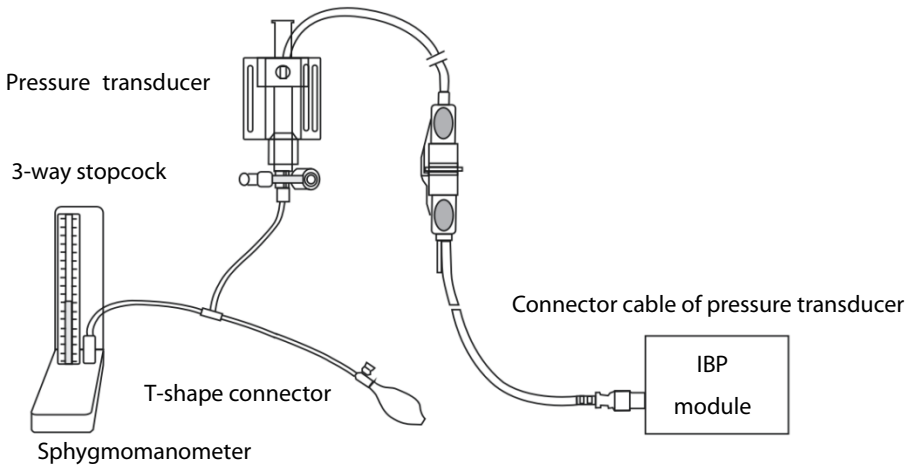
The message **Calibration Completed!** is displayed after a successful calibration. Otherwise, a corresponding message will be displayed.

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

Tools required:

- Medsim300B Patient simulator, 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 37ºC on the patient simulator and check the temperature value is 37±0.1ºC.
3. Select CCO parameter interface to access the **C.O. Measure** interface. Then, select **Setup** to check whether the value of **CatheterType** is PV2015L20.
4. Turn the injectate temperature (TI) knob on the C.O. adapter box to set the TI to 20±1ºC 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±1ºC, and then quickly back to 20±1ºC. 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.

4.4.16 NMT Tests

Performance Test

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.

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

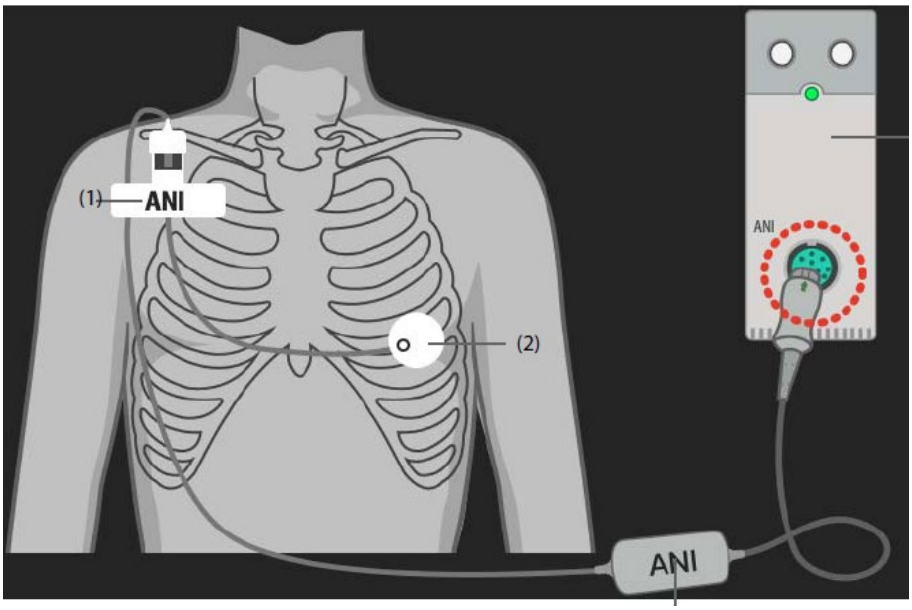
- **Stop NMT measurement or calibration before starting NMT sensor check.**
- **Avoid forcefully striking the sensor.**

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

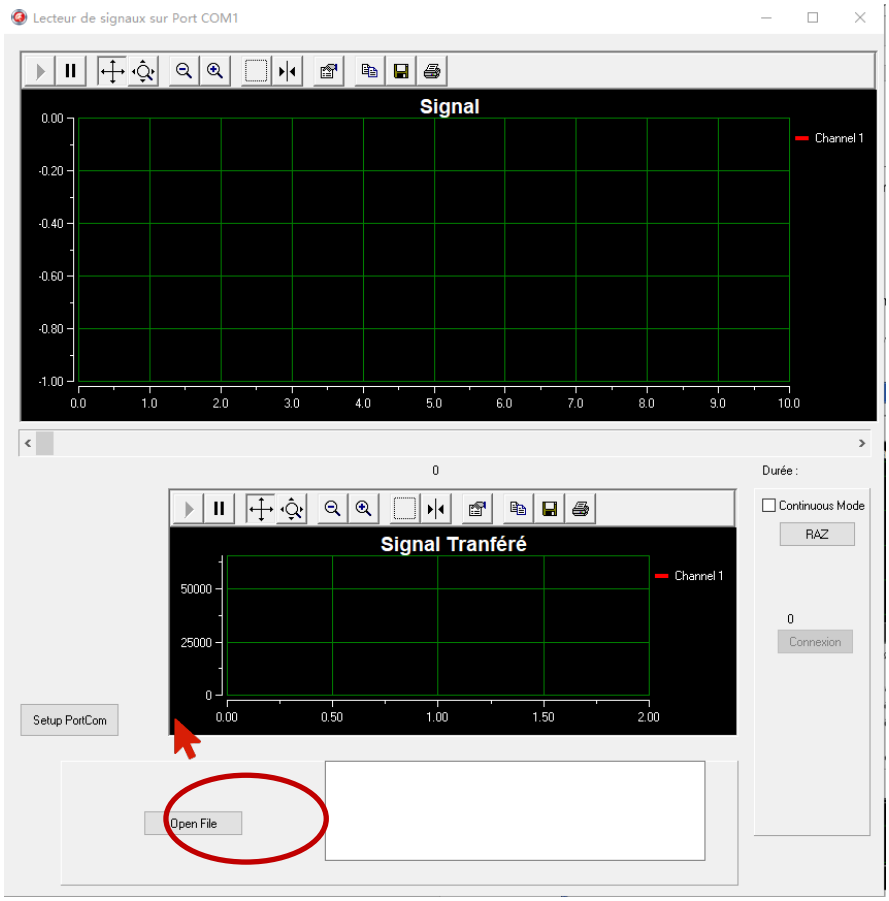
Test tools:

- 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.

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 **Alm Lev** and **Alarm Cat.** 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

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

4.8 Touchscreen Calibration (Resistive Touchscreen)

Tools required:

- None.

1. Select **Main Menu** → **Cal Touchscreen**.
2. The  symbol will appear at different positions on the screen.
3. Touch, in turn, the central point of the  symbol.
4. After the calibration is completed, select **Ok** to confirm the completion of the calibration.

4.9 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.

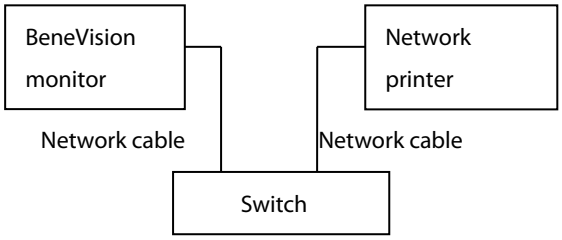
4.10 Network Print Test

NOTE

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

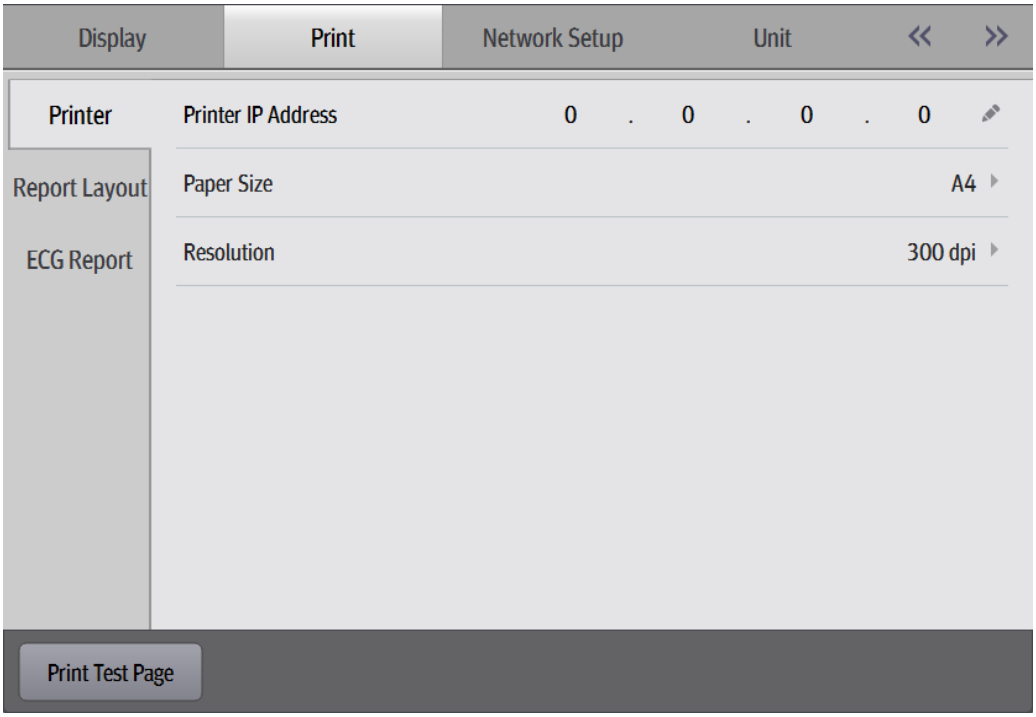
4.10.1 Device Connection and Setup

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.

The settings screen is shown in the following figure:



4.11 Device Integration Check

Refer to ***BeneLink Module Operator's Manual***.

4.12 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.

4.13 Mounting Check

Tools required:

- None.

Safety check

Check the mounting of Patient Monitor is safe.

4.13.1 Overall Test and Check of Installed System

Implement installation test:

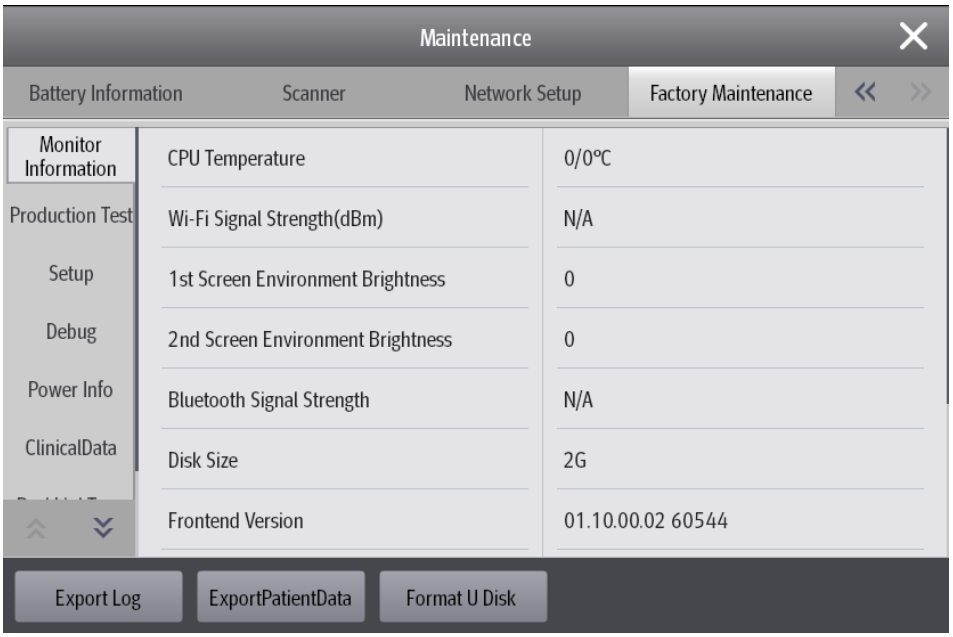
The following tests and checks need to be performed after a patient monitor is installed, or reinstalled after being disassembled and repaired:

- Check that the screws fastening the bracket and guide rail are not loose.
- Check that the four installation screws on the rear side of the main unit are not loose.
- Check that the main unit and the VESA metal plate are closely attached.
- Check that the connection between stand and bracket is not loose.
- Check that the screws at the installation support leg for fixing fast lock are not loose.
- Check that the fast lock or lock plug at the rear side of the module rack is not loose.
- 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 display handle is not loose.
- Check that the length of display wire allows for flexible turn of the display and angle adjustment of the monitor.
- Check that the monitor can be placed at any angle as required.
- Check that the VHM bracket can place the monitor at any height as required.
- Check that the screws on the rotation part of the display are securely installed, and that the damping force is properly set.

4.14 Factory Maintenance

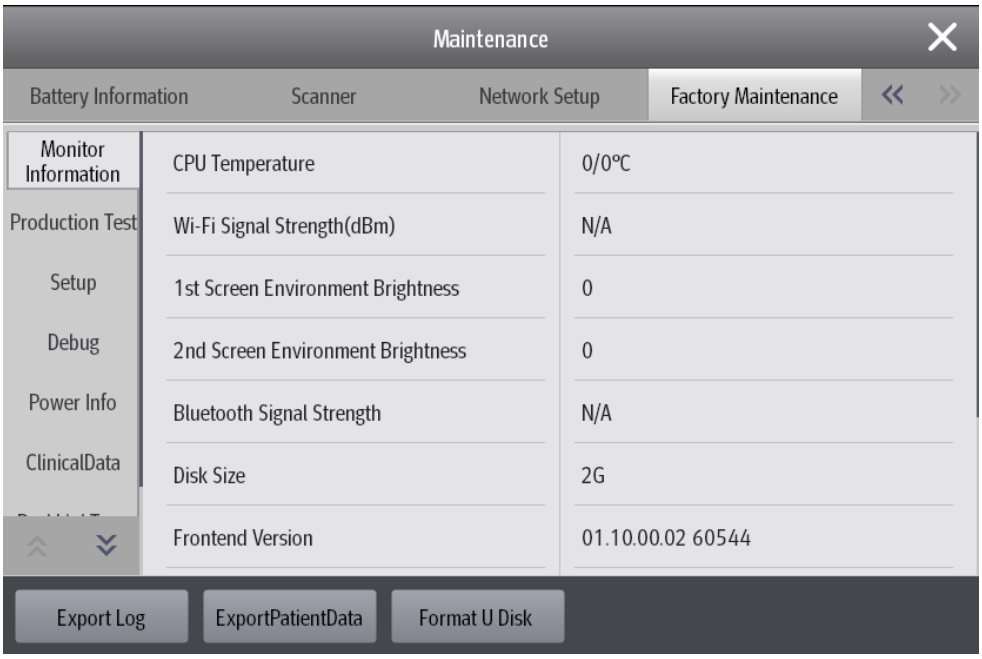
4.14.1 Accessing Factory Maintenance Menu

Select **Main Menu** → **Maintenance** (input the correct password) → **Factory Maintenance** to open the **Factory Maintenance** menu, as shown in the following figure**.**



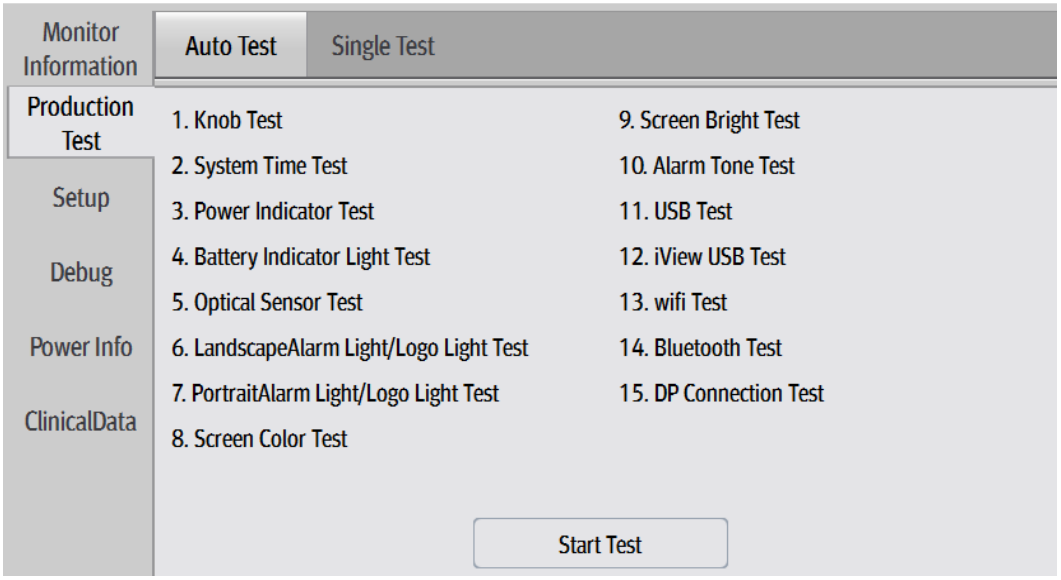
4.14.2 Monitor Information

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



4.14.3 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.



4.14.4 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.

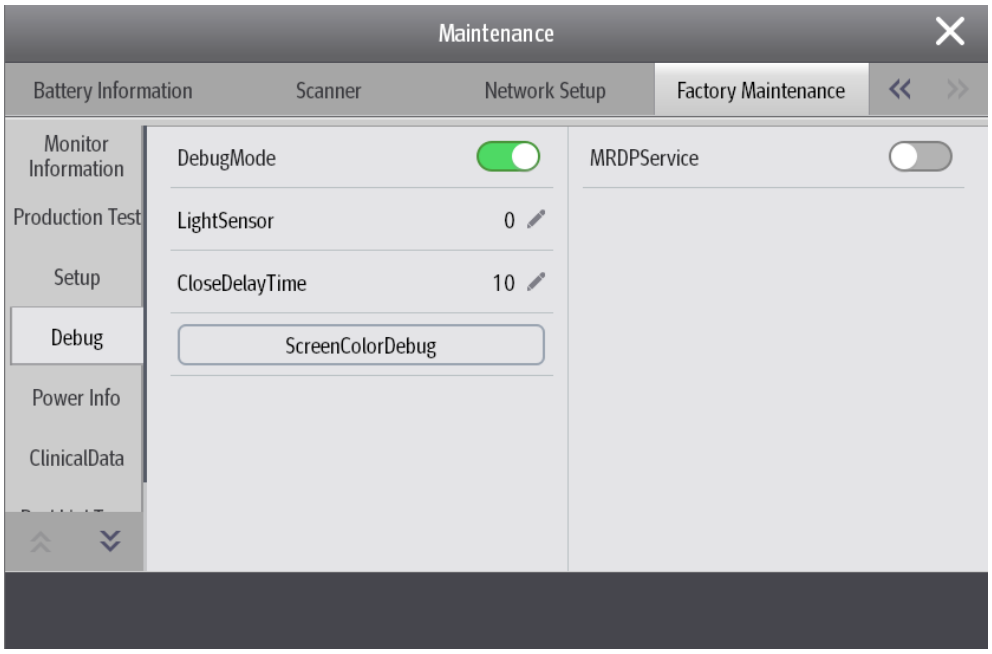
ESN: Enter the electronic serial number.

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.

4.14.5 Debug

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

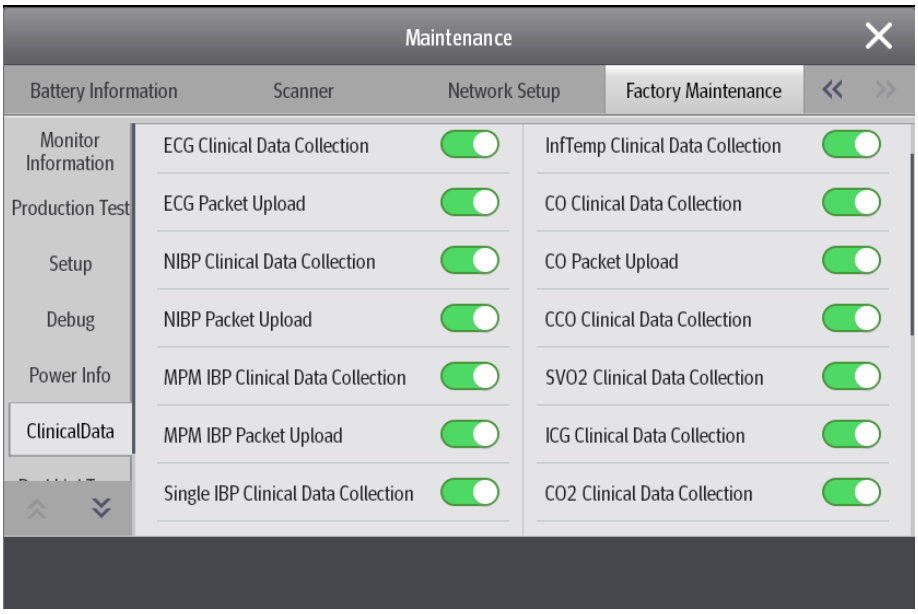


4.14.6 Power Info

This tab page displays information about power supply.

4.14.7 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.**

4.14.8 Transferring Clinical Data

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

4.14.9 Software Version

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

4.14.10 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, knob, 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 80±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 40±2 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%.		
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±0.1°C.		
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		

Test items	Test records	Test results(Pass/Fail/NA)
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 CO_2 Filterline Err is given. It indicates that there is no leakage.		
The displayed CO_2 value is 6±0.05%.		
Microstream CO_2 test		
Block the gas inlet of the module or watertrap for about 30 seconds. An alarm of CO_2 Filterline Err is given. It indicates that there is no leakage.		
The displayed CO_2 value is 6±0.05%.		
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.		
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: Connect to the BIS simulator to perform a cyclic impedance check. The EEG wave and BIS numeric are displayed on the monitor.		
RM test		
The pressure test is passed.		
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		
Method 2: C.O. measurement result is normally displayed.		

Test items	Test records	Test results(Pass/Fail/NA)
The displayed static pressure values of pArt and pCVP are no more than 200±2 mmHg.		
The waveforms of pArt and pCVP are displayed correctly.		
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 2: 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		
Earth impedance is not greater than 0.1 Ω.		
The enclosure leakage current is not greater than 100 μA in normal condition and is not greater than 500 μA in single fault condition.		
The earth leakage current is not greater than 500 μA in normal condition and is not greater than 1000 μA in single fault condition.		
The leakage auxiliary current for CF applied parts is not greater than 10 μA in normal condition and is not greater than 50 μA in single fault condition.		
The leakage auxiliary current for BF applied parts is not greater than 100 μA in normal condition and is not greater than 500 μA in single fault condition.		
When 110% of the mains voltage is applied to the selected applied part terminals, the patient leakage current for the CF applied parts is not greater than 50 μA.		
When 110% of the mains voltage is applied to the selected applied part terminals, the patient leakage current for the BF applied parts is not greater than 5000 μA.		
The patient auxiliary current for CF applied parts is not greater than 10 μA in normal condition and is not greater than 50 μA in single fault condition.		
The patient auxiliary current for BF applied parts is not greater than 100 μA in normal condition and is not greater than 500 μA in		

Test items	Test records	Test results(Pass/Fail/NA)
single fault condition.		
Touchscreen calibration		
The touchscreen is calibrated successfully.		
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 network printer can print out ECG reports correctly.		
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.		
T5 patient monitor can operate independently on a single battery.		
The operating time of the battery meets the product specification.		

Conclusion:

Qualified or not: (Yes No)

Signature of tester: Date:

5 Hardware Upgrade

5.1 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 reinstallation. Do not drop, contaminate or lose them.**

5.2 Upgrade of Parameter Function Modules

You can upgrade the following parameter modules:

Monitoring Parameter Module	PN	Name and Specification	Remarks
New MPM modules	/	New MPM-1 module main unit (MR SpO_2/3/5-lead/English/CE)	/
	/	New MPM-3 module main unit (NC SpO_2/3/5-lead/English/CE)	/
	/	New MPM-13 module main unit (MR SpO_2/12-lead/analog output/Chinese)	/

Monitoring Parameter Module	PN	Name and Specification	Remarks
	/	New MPM-14 module main unit (NC SpO_2/12-lead/analog output/Chinese)	/
SpO_2 modules	/	SPO_2 module main unit in English (Mindray 9008 V2.0)	/
	/	Main unit of single-slot Nellcor SpO_2 module	/
CO_2 modules	/	Single-slot CO_2_O_2 module main unit (configure with paramagnetic oxygen)	
	/	ORIDION CO_2 module main unit (English)	
	/	One-slot CO2 Module	/
	/	CAPNOSTAT CO_2 module main unit	/
AG modules	/	Double-slot anesthesia module main unit (without oxygen)	/
	/	Double-slot anesthesia module main unit (with oxygen)	/
	/	Double-slot anesthesia module main unit (without oxygen/with BIS)	/
	/	Double-slot anesthesia module main unit (with oxygen/with BIS)	/
Single-slot RM module	/	2G single-slot RM module main unit	/
NMT module	/	NMT module main unit	/
BIS module	/	BIS module main unit	/
EEG module	/	EEG module main unit	/
IBP module	/	IBP module main unit (EBR095 switched to M03B)	/
Medis ICG module	/	Medis ICG module main unit	/
CO module	/	C.O.Module(M03B V2.0)	/
Picco module	/	Picco module main unit	/
$ScvO_2$ module	/	$ScvO_2$ module main unit	/
CCO/SvO_2 module	/	CCO/SvO_2 module main unit	/
Device interconnection module	/	Device interconnection module	/
Recorder module	/	Recorder module main unit	/
Temp Module (CE)	/	Temp Module (CE)	/
Infrared ear temperature Module (CE)	/	Infrared ear temperature Module (CE)	/

You can insert and remove all the parameter modules during patient monitoring.

For how to insert and remove parameter modules, see ***BeneVision N22/N19 Patient Monitor Operator's Manual***.

5.3 Upgrade of Functional Assemblies

You can upgrade the following functional assemblies for this monitor: upgraded of satellite module rack (SMR), secondary display, split unit, wireless network, handle encoder, main unit battery, module rack hook, iView assembly, and other hardware configuration.

Functional Assembly	PN	Name and Specification	Remarks
Module rack		Module rack material package (2M wire/including the handle and hook)	/
		Module rack material package (10M wire/including the handle and hook)	/
		Module rack material package (2M/excluding the handle)	/
Secondary display		22″ secondary display (including the AC adapter and 2.3 m cable for secondary display)	/
		22″ secondary display (including the AC adapter and 10 m cable for secondary display)	/
		19″ secondary display (including the AC adapter and 2.3 m cable for secondary display)	/
		19″ secondary display (including the AC adapter and 10 m cable for secondary display)	/
Split unit		Spit accessory material package (with the rotation function)	/
Wireless WiFi		WiFi material package	/
Handle assembly		Handle assembly (without encoder)	/
		Handle assembly (with an encoder)	/
Main unit battery		Battery	/
Module rack hook		Module rack hook upgrade package	/
iView module		iView material package (Chinese)	/
Remote controller kit		Remote controller kit	/
2D barcode scanner		2D BarCode Scanner (support RFID) kit	/

This monitor is configured with wireless network functions. 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.

5.3.1 Upgrading SMR

The SMR can be connected to the patient monitor through the SMR connector via a powered USB cable. For details, see ***BeneVision N22/N19 Patient Monitor Operator's Manual***.

5.3.2 Upgrading Secondary Display

To implement normal operation, use the video cable connection line to connect the secondary display to the secondary display interface of monitor, connect the power supply, and turn on the secondary display. For details, see ***BeneVision N22/N19 Patient Monitor Operator's Manual***.

5.3.3 Upgrading Split Unit

Split unit assembly: Refer the corresponding section of this manual to split the integrated monitor into split type monitor.

For details, see ***BeneVision N22/N19 Patient Monitor Operator's Manual***.

5.3.4 Upgrading Wireless Network Functions

- How to implement wireless WiFi assembly: Refer to the corresponding section of this manual to install the wireless network functional assembly in your patient monitor.
- How to use wireless network functions: See ***BeneVision N22/N19 Patient Monitor Operator's Manual***.

5.3.5 Upgrading Handle Assembly

- How to install the handle assembly: Refer to the corresponding section of this manual to install the handle assembly in your patient monitor.
- How to use the handle assembly (with an encoder): See ***BeneVision N22/N19 Patient Monitor Operator's Manual*** .

5.3.6 Upgrading Main Unit Battery

- How to install the main unit battery: Refer to the corresponding section of this manual to install the main unit battery in your patient monitor.

5.3.7 Upgrading iView System Functions

- Installation method: Refer to the corresponding section of this manual to install the iView system function assembly in your patient monitor.
- How to use iView system functions: See ***iView System Operator's Manual***.

NOTE

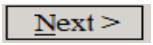
- **During upgrade of iWiew and handle assembly, the interface cover and handle cover need to be removed in addition to installing the corresponding functional assembly in your monitor.**

6 Software Upgrade

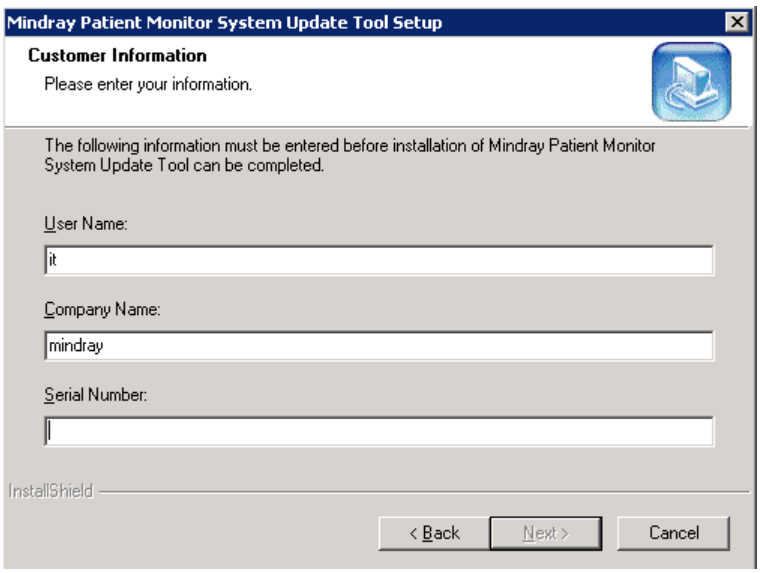
You can upgrade the software with the System Update Tool (PN: 110-003608-00 PC Upgrade Tool) through network. This tool can directly run on a PC. Through network or by connecting the patient monitor to a PC via a crossover network cable, you can upgrade the following programs:

Software	PN	Name and Specification	Remarks
System software package	/	Large BeneVision software package	/
Module rack software	/	Bluetooth firmware function program	/
	/	8-slot board FPGA write software	/
Secondary display software	/	Display interface control board firmware	/
MPM modules	/	M51A V2.0 BD module DSP (BF512) software	ECG algorithm 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 (BD)	/
CO module	/	M03B module write software (BD)	/

6.1 Tool Software Installation Method

Click the executive program "SystemUpdateTool.exe" of the system upgrade tool software to display the language selection interface. After you select the corresponding installation language as prompted and confirm it, the related prompt interface will be displayed. Click 

to enter the input interface of the information about user name, company name and SN.



Enter the corresponding user name, company name and SN information, and click Next > to enter the administrator password setting interface. Enter the administrator password and verifying password (the two should be the same) that can be easily remembered according to the interface prompt, and click Next > to enter the program installation location interface. Select the corresponding folder for installation, and click Next > to complete installation according to the installation prompt.

6.2 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.

- PC connected to the monitor through the hub
  - I. 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.
  - II. 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.
- Changing the IP address of PC network card

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”.

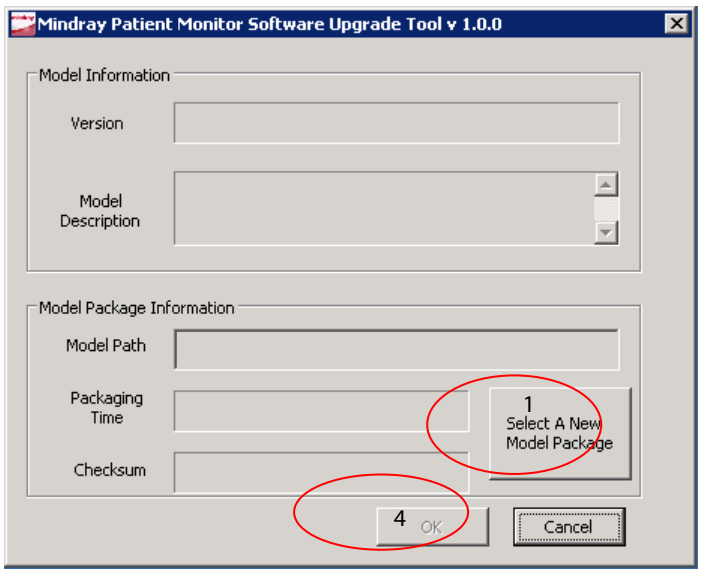
6.3 How to enter the upgrade mode:

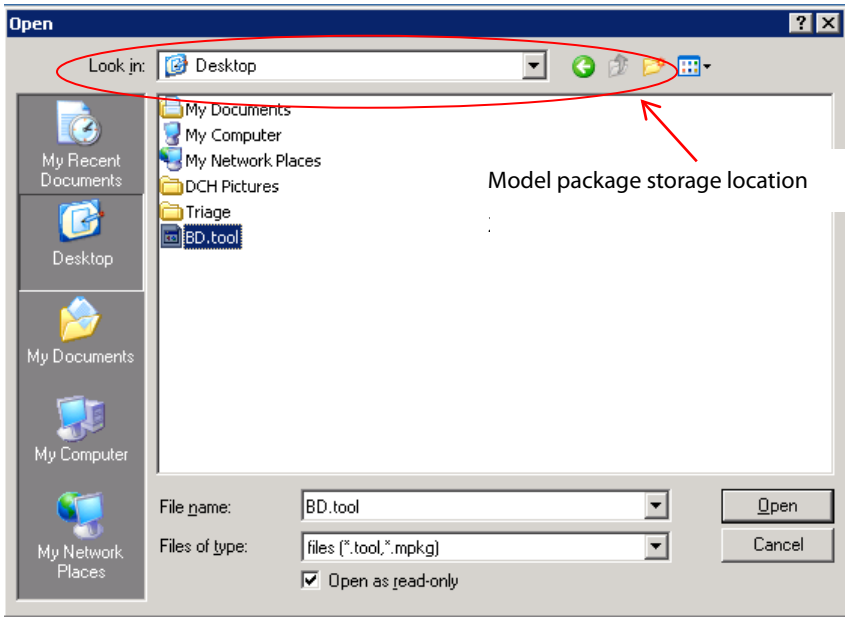
- Method 1: Connect the monitor to the USB keyboard. When starting the monitor, constantly click 'F4+F5' or '*' key at the same time to enter the upgrade mode.
- Method 2: When starting the monitor, use two or more fingers to continuously and rapidly tap the screen to enter the upgrade mode.

6.4 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:

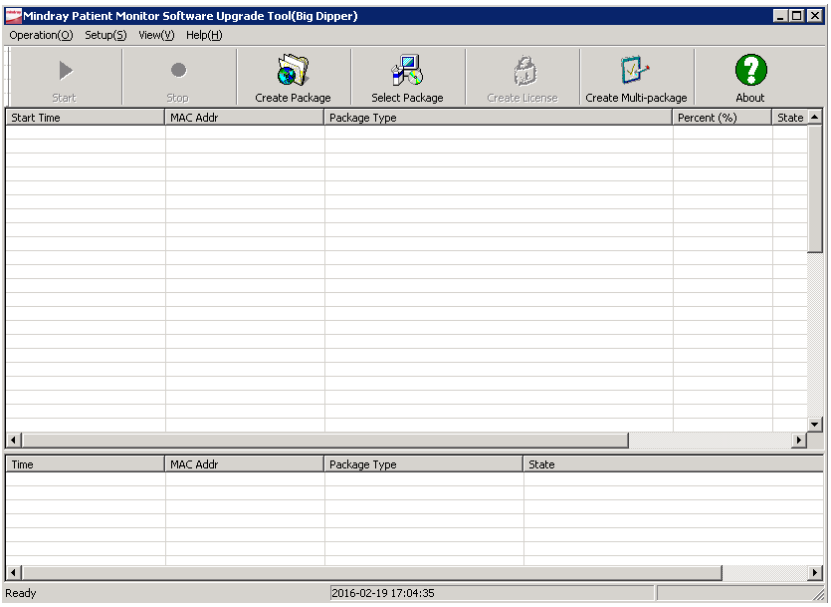
1. Download the large software package of N22N19 system (the storage location is the model package path), run the installed system (network) upgrade tool software, click **Select New Model Package**, select the “BD.tool” model package, click **Open**, and then click **OK**, as shown in the following figures:





On the displayed machine type selection interface, select the machine type “Big Dipper”.

The following interface is displayed on the PC:

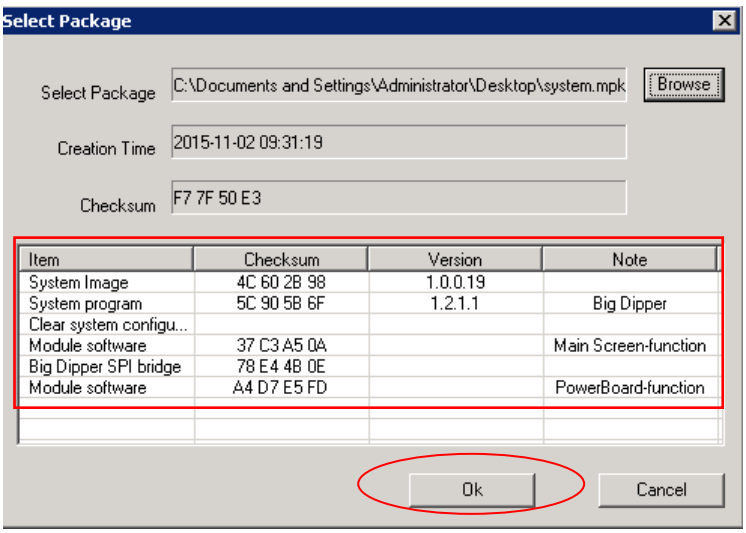


6.5 Guide to Software Upgrade Operations

6.5.1 System Software Upgrading Method

Enter the main interface for downloading of system upgrade, 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 now.



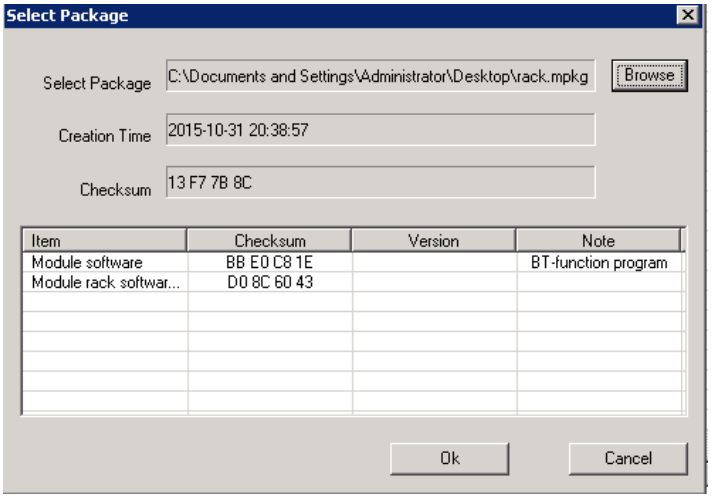
Confirm that the downloading network cable is connected correctly, make sure that the monitor has been powered off, and click the **Start** hot key of the upgrade tool to enter the downloading procedure of software.

6.5.2 Upgrading Module Rack Software

1. First connect the SMR connection line to the multi-function interface of N22/N19 main unit (the system software has been upgraded, and the main unit is off), connect the downloading network cable to the N22/N19 main unit (the same as the connecting method for upgrade of the N22/N19 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 N22/N19 system:



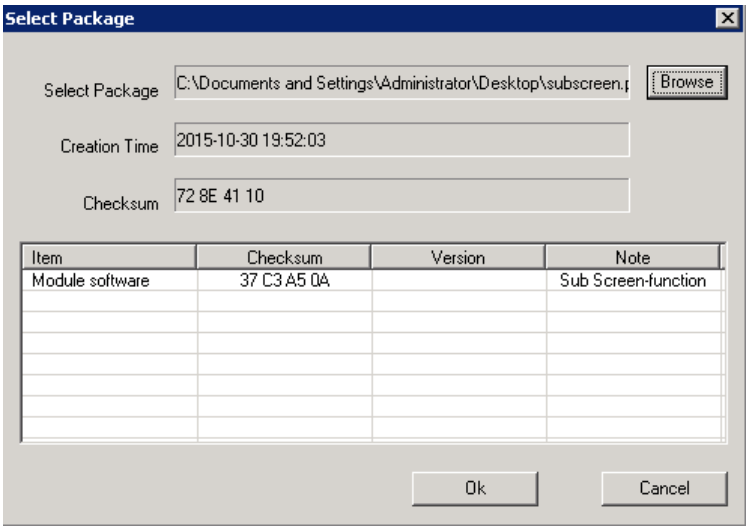
3. Upgrade the SMR upgrade program by referring to “System Software Upgrading Method”.
4. If the upgrade fails, check whether all the wires are connected correctly, and then perform upgrade again.

6.6 Upgrading Secondary Display Software

1. Use the 009-005118-00 2.3m USB cable and 009-005115-00 2.3m video cable to connect the secondary display to the N22/N19 main unit (the system software has been upgraded, and the main unit is off), use the 022-000250-00 adapter to power the secondary display, connect the downloading network cable to the N22/N19 main unit (the same as the connecting method for upgrade of the N22/N19 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 SubScreen.pkg file in the large software package of N22/N19 system:



3. Upgrade the secondary display 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.

6.7 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.

⚠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.**

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.**

6.8 Guide to Upgrade through a USB Disk

6.8.1 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\ Bigdipper.
2. Copy the upgrade BIOS program BD_Installer.pkg (do not change this file name) to the UPGRADE_AMP\ Bigdipper directory.
3. Copy the upgrade file (PKG or MPKG) to the UPGRADE_AMP\ Bigdipper directory.

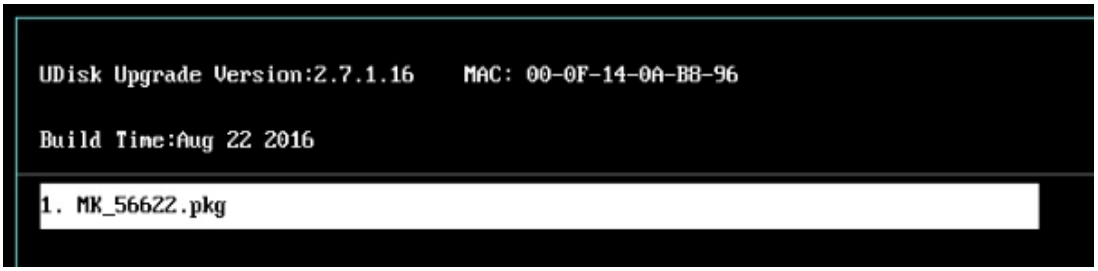
6.8.2 Inserting the USB Disk into the USB port of the Monitor

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.

6.8.3 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.

6.8.4 Selecting the File for Upgrade through the USB Disk



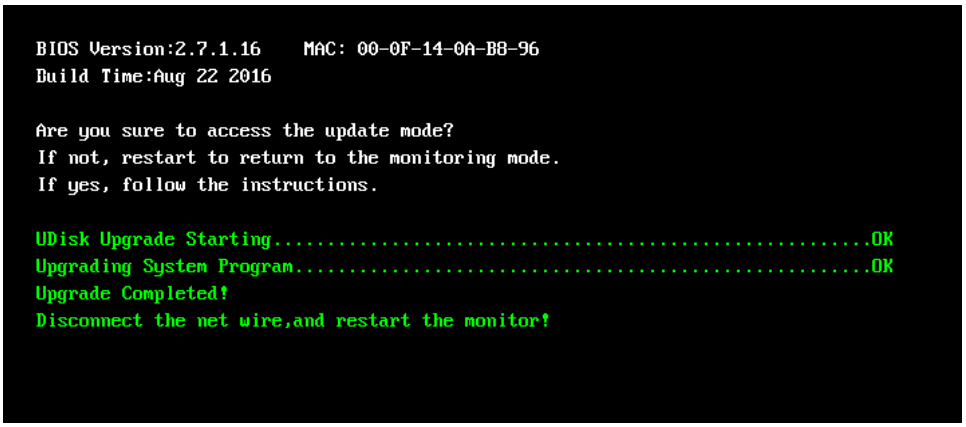
- Only one upgrade package file is available at present. It is selected by default. If multiple upgrade packages exist, they are displayed in the left and right columns, and a maximum of 16 upgrade packages can be displayed. This upper limit cannot be exceeded. The up, down, left and right keys can be used to switch and select the desired upgrade package.
- Tap the 

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.

6.8.5 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.**

6.9 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)
- 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.

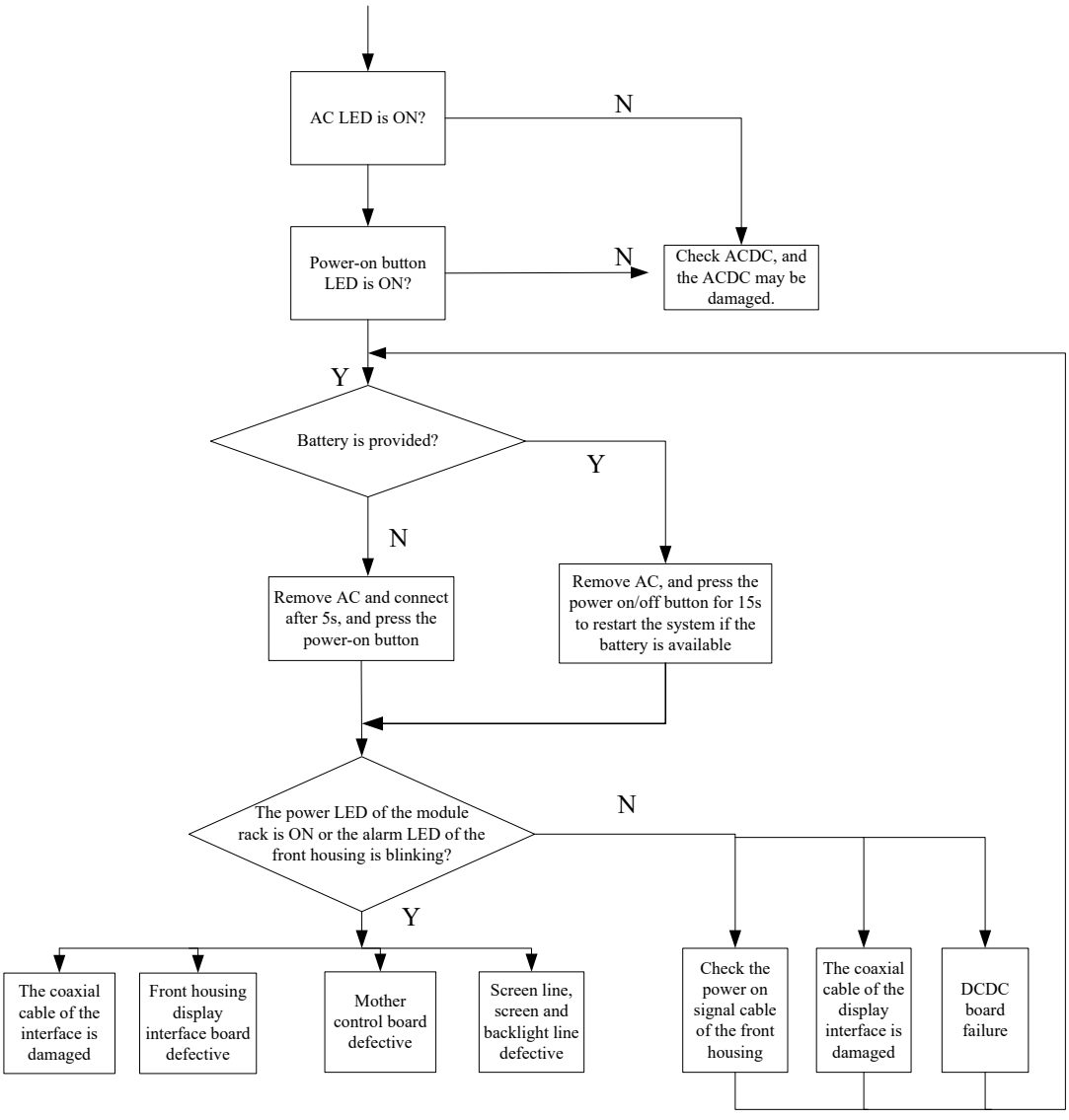
NOTE

- **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 Troubleshooting

7.1 Blank Screen upon Startup



Arranged according to the possible order

7.1.1 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:

- Select Main Menu → Select System>> → Select Version >>. In the displayed menu, you can check the system software version.
- Select Main Menu → Select Maintenance >> → enter the required password → Select Version >>. In the displayed menu, you can check the version information of the system software and modules.

7.2 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.

Message	Severity	Alarm Clearing	Causes and Countermeasures
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 of batteries	Low	Cannot be cleared	Check the number 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

Message	Severity	Alarm Clearing	Causes and Countermeasures
			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 storage space is nearly full. Please delete some discharged patients.	Med	Audible and visual display can be cleared	Delete unnecessary earlier discharged patient.

7.3 Troubleshooting Guide

7.3.1 Power On/Off Failures

Fault Symptom	Possible Cause	Countermeasure
Power on failure	AC mains not connected or insufficient battery power	Verify the AC mains is properly connected or battery capacity is sufficient.
	Power supply protection	Remove the AC power supply and batteries, and restart the monitor after more than 15s.
	Cable defective or improperly connected	Verify the cables connecting the power switch and the LED board to the front housing interface board, the cable connecting the front housing interface board to the coaxial cable of main control, and the cable connecting the power module to the DCDC board are properly connected. Note: The process for the coaxial cable connecting the front housing interface board and the main control is complicated; therefore, protective measures must be adopted during installation to prevent the coaxial cable from being damaged. 2. Verify the cables and connectors are not damaged.
	Power switch & LED board defective	Replace the power switch & LED board.
	Power module defective	Replace the power module.
	Motherboard failure	Replace the motherboard.

7.3.2 Display Failures

Fault Symptom	Possible Cause	Countermeasure
Blank screen, but the patient monitor still operates normally	Cable defective or improperly connected	1. Verify the cable connecting the power switch and the LED board to the front housing interface board, the cable connecting the front housing interface board to the coaxial cable of main control, and the cable connecting the power module to the DCDC board are properly connected. 2. Verify the connecting cables and connectors are not damaged.
	LCD defective	Replace the LCD.
Secondary screen does not function	Cable defective or improperly connected	1. Verify the cable connecting the display DP1 connector and the patient monitor is properly connected. 2. Verify the cables and connectors are not damaged.
	DP cable of the secondary screen is inserted into the connector of the main unit when the system is powered on	Power off and restart the main unit.
	Switch of the secondary screen is in the power off state	Press the power-on button of the secondary screen for 5s to start the secondary screen.
Touchscreen does not respond	Touchscreen disabled	Check if there is a symbol  shown above the Main Menu QuickKey. If yes, press Main Menu for more than 3s to enable the touchscreen.
	Cable defective or improperly connected	1. Verify the cables connecting the touchscreen to the touchscreen control board, the cable connecting the touchscreen control board to the front housing interface board, and the cable connecting the front housing interface board to the main board are properly connected. 2. Verify the cables and connectors are properly connected
	Touchscreen control board defective	Replace the touchscreen control board.
	Front housing interface board failure	Replace the front housing interface board.
	Touchscreen defective	Replace the touchscreen.

Fault Symptom	Possible Cause	Countermeasure
Touchscreen accuracy is off	Touchscreen not calibrated	Calibrate the touchscreen.

7.3.3 Module Rack Failures

Fault Symptom	Possible Cause	Countermeasure
SMR		
SMR power LED is ON, but the system could not identify the parameter module	Hot plugging of the module rack	Restart the system.
	External cable defective or poorly connected	1. 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. 2. Verify that contact screws on SMR or module are tightly fastened and well connected.
	Module damaged	Replace the module. If a new module is identified, the original one is damaged.
	Module rack interface board failure	Replace the module rack interface board.
	8-slot module rack communication board damaged	Replace the 8-slot module rack communication board.
	DCDC board failure	Replace the DCDC board.
SMR power LED off	SMR failure	Replace the SMR.
	Cable defective or improperly connected	Verify the connecting cables and connectors are not damaged.
	DCDC board failure	Replace the DCDC board.
	Main board failure	Replace the main board.

7.3.4 Alarm Failures

Fault Symptom	Possible Cause	Countermeasure
Alarm LED off or cannot be turned off while the audible alarm is sounding	Cable defective or improperly connected	1. Verify the cable connecting the alarm LED board to the front housing interface board, and the cable connecting the front housing interface board to the main board are properly connected. 2. Verify the cables and connectors are not damaged.
	Alarm LED board failure	Replace the alarm LED board.
	Front housing interface board failure	Replace the front housing interface board.
	Main board failure	Replace the main board.
No audible alarm sounds emitted while the alarm LED is normal	Audible alarm disabled	Select Main Menu → Select System>> → Select Maintenance >> → enter the required password → Select Alarm >>, and then in the popup menu, set Minimum Alarm Volume to a proper value. Select Alarm >>, → Select Setup >> to adjust the alarm volume to a proper value.
	Cable defective or improperly connected	1. Verify the cable connecting the speaker to the main board is properly connected. 2. Verify the cables and connectors are not damaged.
	Speaker failure	Replace the speaker.
	Main board failure	Replace the main board.

7.3.5 Output Interface Failures

Fault Symptom	Possible Cause	Countermeasure
No output for the nurse call	Respective output disabled	1. Select Main Menu → Select Analog Output Setup → set Analog Output to On.
	DCDC interface board cable loose	1. Verify the cable connecting the DCDC interface board to the main board is properly connected. 2. Verify the cables and connectors are not damaged.
	DCDC interface board damaged	Replace the DCDC interface board.
	Main board failure	Replace the main board.
Connected USB devices not working (it is assumed these devices are working properly when connected elsewhere)	USB enumeration failure	Restart the system.
	Cable defective or improperly connected	1. Verify the cable connecting the USB Hub board to the main board is properly connected. 2. Verify the cables and connectors are not damaged.
	USB Hub board failure	Replace the USB Hub board.
	Main board failure	Replace the main board.

7.3.6 Power Supply Failures

Fault Symptom	Possible Cause	Countermeasure
Power Supply Failures	Battery damaged	Replace the battery.
	Cable defective or improperly connected	1. Verify the cable connecting the battery interface board to the power module is correctly connected. 2. Verify the cables and connectors are not damaged.
	DCDC interface board damaged	Replace the DCDC interface board.
Battery cannot be recharged	Battery damaged	Replace the battery and charge fully. If this is successful, the original battery is faulty.
	Cable defective or improperly connected	1. Verify the cable connecting the battery interface board to the DCDC interface board is correctly connected. 2. Verify the cables and connectors are not damaged.
	DCDC interface board damaged	Replace the DCDC interface board.

Fault Symptom	Possible Cause	Countermeasure
No +3.3 V output	1. Power supply protected 2. DCDC interface board damaged	1. Turn off the patient monitor then restart it. 2. If the problem persists, disconnect the AC mains for 5s and reconnect it, and then restart the patient monitor. 3. If the problem persists, replace the DCDC interface board.
No +5.0 V output		
No +12 V output		

NOTE

- **When the power module fails, it may cause damage to other components, e.g. the monitor suddenly fails during start-up, due to supply protection. In this case, troubleshoot the power module by following the procedure described in the table above.**
- **Components of the main unit, SMR and parameter modules are powered by the power module. In the event that a component malfunctions, verify the operating voltage is correct. Refer to Chapter 2 Theory of Operation for the operating voltage and measurement points for each component.**

7.3.7 Network Related Problems

Fault Symptom	Possible Cause	Countermeasure
Frequent dropouts or network disconnects	Improper network cable connection	Check for network cable connection and length (should not exceed 50 m).
	Incorrect IP configuration	Check for IP conflict in the network and reset the IP address.
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 (should not exceed 50 m).
	Too many simultaneous requests for viewing the patient monitor	One monitor could only be observed by eight monitors simultaneously, and the observing requests not within the range would not be handled.
	Incorrect IP configuration	Check for IP conflict in the network and reset the IP address.

7.3.8 Software Upgrade Problems

Fault Symptom	Possible Cause	Countermeasure
Bootstrap upgrade fails	Power failure or unintended power-off during bootstrap upgrade	Restart the upgrade after power off
Program upgrade fails	Incorrect connection	1. Verify the network is connected to network interface 1 of the monitor instead of network interface 2 or iView network interface. 2. Ensure the normal operation of the network hub or switch, and verify the hub cable or crossover cable is properly connected.
	Wrong upgrade package has been downloaded	The upgrade package should be a file suffixed by .pkg, and the corresponding upgrade package should be selected for the program you upgrades.
	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.

7.3.9 Technical Alarm Messages

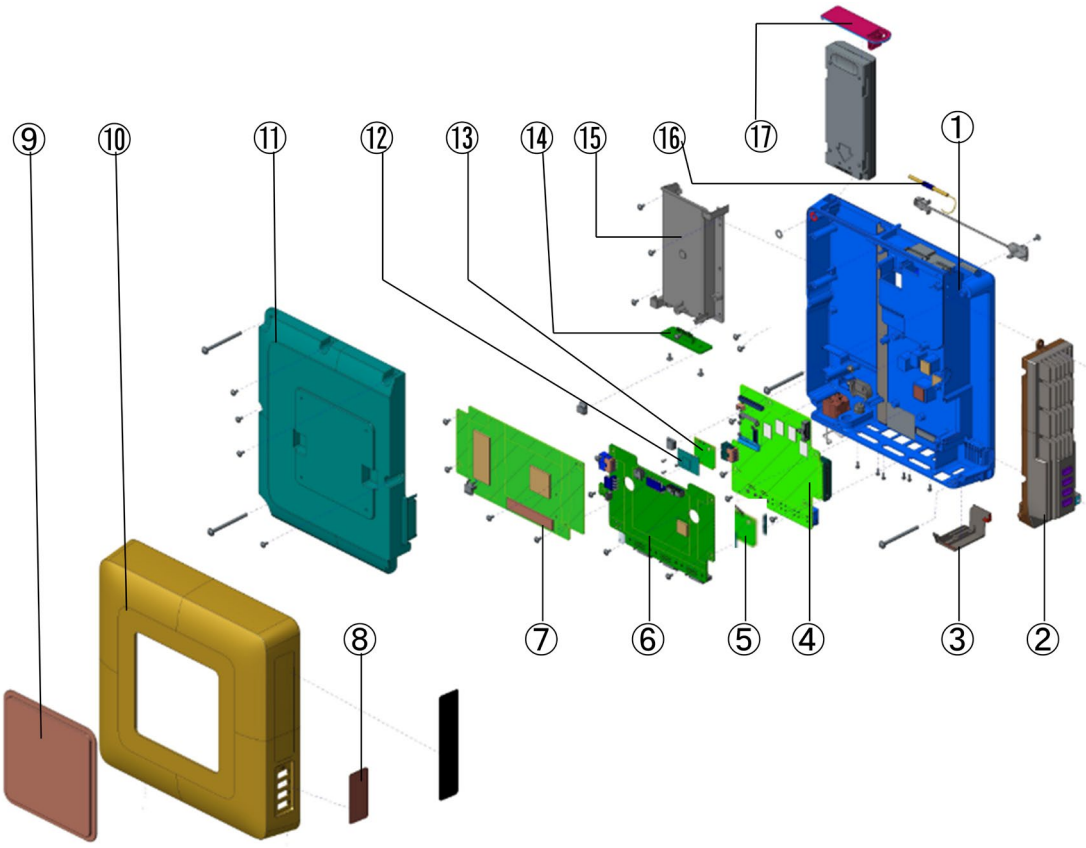
Please refer to ***BeneVision N Series Patient Monitor Operator's Manual***.

FOR YOUR NOTES

8 Parts

8.1 Main Unit

8.1.1 Exploded View



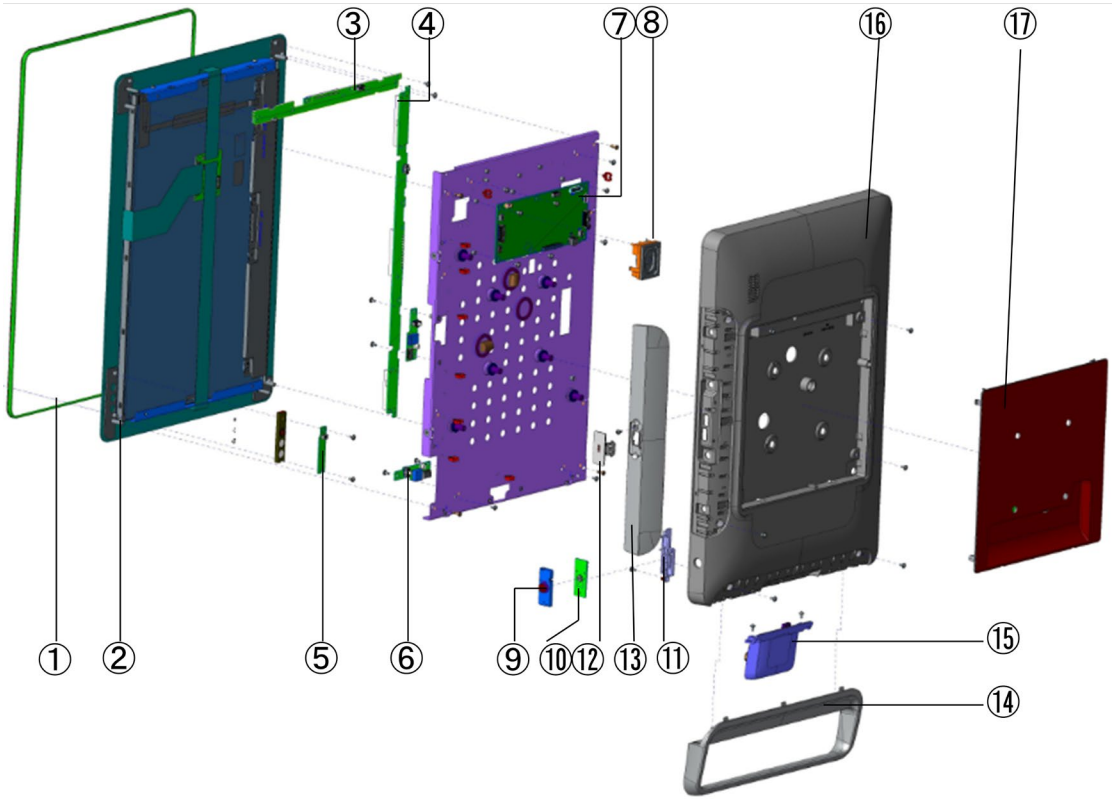
8.1.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-037485-00	Main unit base assembly	1	/
2	115-037269-00	iView module	1	/
3	043-005815-01	DP port decoration cover(ESM)	1	replace 043-005815-00
4	115-037490-00	Main control board PCBA Bay-Trail E3827 2GDDR	1	/
5	115-072026-00	SSD FRU (2G)	1	/
	115-072027-00	SSD FRU (8G)		/
6	115-037491-00	Main unit interface and DC-DC board PCBA	1	/

No.	Order Number	Part Description	Qty	Remark
7	022-000249-00	Power supply 90-264VAC 16V/10A	1	/
8	043-009126-00	USB port decoration cover(ESM)	1	replace 043-005816-00
9	043-006885-01	Host ornamental cover silk screen	1	replace 043-006885-00
10	115-037486-00	Main Unit outside housing Assembly	1	/
11	044-000660-00	Upper cover of main unit	1	/
12	024-000707-00	Raido module support IEEE 802.11a/b/g/n	1	WiFi module
13	051-001926-00	Carrier Board of Wireless Module(PCBA)	1	/
14	051-001932-00	6600 battery interface board PCBA	1	/
15	043-005814-00	Battery cavity assembly	1	/
16	024-000717-00	WiFi antenna 2.4GHz and 5GHz dual frequencies	1	/
17	043-006168-00	Main unit battery door (overmold)	1	/

8.2 D22/D19 Display Assembly (Capacitive Screen)

8.2.1 Exploded View

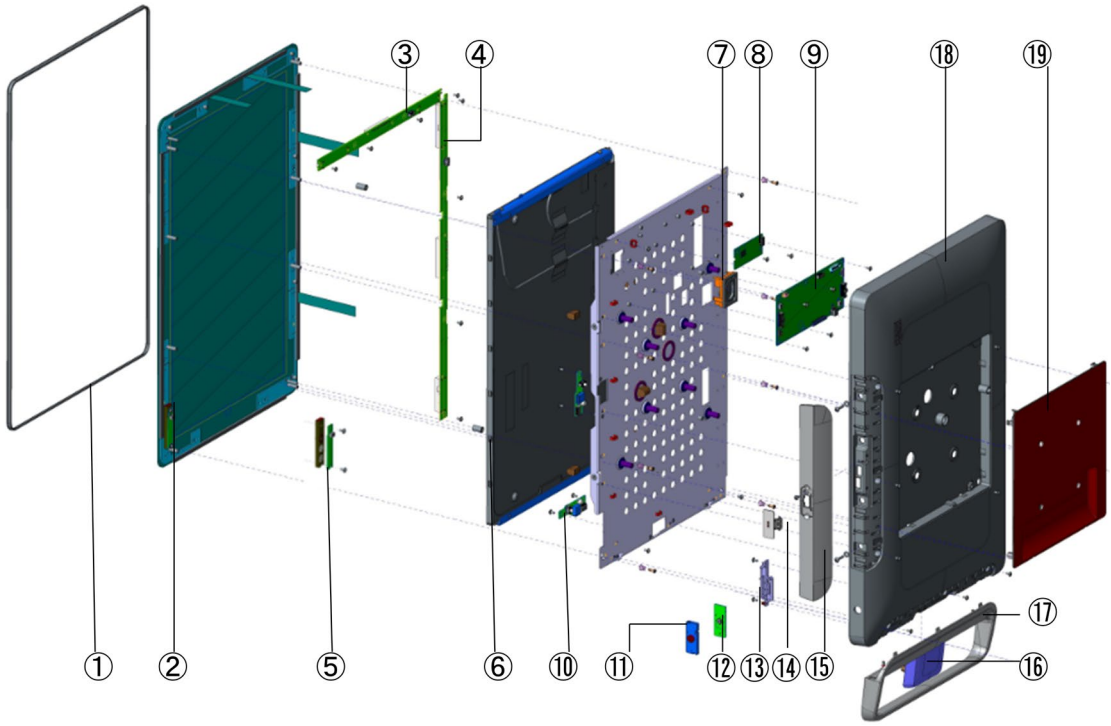


8.2.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-045002-01	D22 ornamental belt(FRU)	1	Used for N22
	115-045003-01	D19 ornamental belt(FRU)		Used for N19
2	115-045000-01	D22 capacitance screen assembly(FRU)	1	1,Included 115-045002-01 2,Together with 043-005871-02 D22 rear housing to replace 115-045000-00
	115-045001-01	D19 capacitance screen assembly(FRU)		1, Included 115-045003-01 2, Together with 043-005820-02 to replace 115-045001-00
3	051-001923-00	22 inch vertical LED board PCBA	1	/
	051-001925-01	19 inch vertical LED board PCBA		Compatible with 051-001925-00
4	051-001922-00	22 inch horizontal LED board PCBA	1	Used for N22
	051-001924-00	19 inch horizontal LED board PCBA		Used for N19
5	051-001918-00	Indicator and light intensity sensor board PCBA	1	/
6	051-001933-01	USB interface board PCBA	2	Compatible with 051-001933-00
7	115-044999-00	Display interface board PCBA (FRU)	1	Capacitive touchscreen, compatible with 115-037494-00
8	115-037489-00	Speaker Assembly	1	/
9	049-001426-00	Switch key assembly(ESM)	1	replace 049-001031-00
10	051-001920-00	Switch keypad board PCBA	1	/
11	043-006119-00	Key seat	1	/
12	043-006004-01	USB cover display(ESM)	2	/
13	115-035456-00	22 inch handle cover Assembly	1	Include 043-006004-01
	115-035457-00	19 inch handle cover Assembly		Include 043-006004-01
14	115-034030-00	Handle assembly (without an encoder)	1	/
15	115-034031-00	Encoder assembly	1	/
16	043-005871-02	D22 rear housing(ESM)	1	together with 115-045002-01 to replace 043-005871-01
	043-005820-02	D19 rear housing(ESM)		together with 043-005820-02 to replace 115-045003-00
17	043-006465-01	Interface cover silk of display back	1	replace 043-006465-00

8.3 D22/D19 Display Assembly (Resistive Screen)

8.3.1 Exploded View



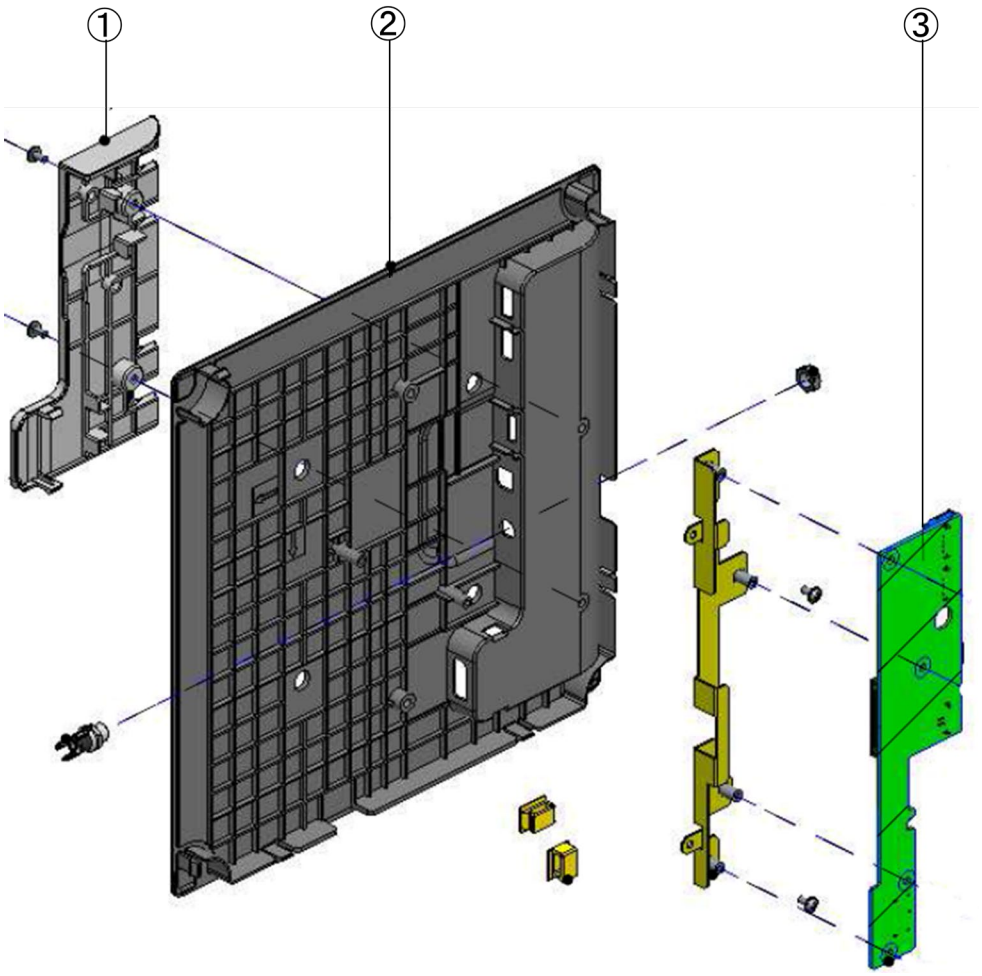
8.3.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-037496-00	D22 Decoration Bar assembly	1	only suitable for resistive touchscreen (N22)
	115-037497-00	D19 Decoration Bar assembly		only suitable for resistive touchscreen(N19)
2	115-037498-00	D22 touchscreen assembly(FRU)	1	include 115-037496-00; used for N22
	115-037499-00	D19 touchscreen assembly(FRU)		When Out of stock, use 115-040801-00 to replace, used for N19
3	051-001923-00	22 inch vertical LED board PCBA	1	Used for N22
	051-001925-01	19inch vertical LED board PCBA		Used for N19 compatible with 051-001925-00
4	051-001922-00	22 inch horizontal LED board PCBA	1	Used for N22
	051-001924-00	19 inch horizontal LED board PCBA		Used for N19
5	051-001918-00	Indicator and light intensity sensor board PCBA	1	/

No.	Order Number	Part Description	Qty	Remark
6	115-037487-00	22-inch display assembly	1	Include 009-005111-00 and 009-005112-00
	115-037488-00	19-inch display Assembly		Include 009-005110-00 and 009-005113-00
7	115-037489-00	Speaker assembly	1	/
8	051-001917-00	Touchscreen control board PCBA	1	/
9	115-037494-00	Display interface board PCBA (FRU)	1	Used for resistive touchscreen
10	051-001933-01	USB interface board PCBA	2	compatible with 051-001933-00
11	049-001426-00	Switch key assembly(ESM)	1	replace 049-001031-00
12	051-001920-00	Switch keypad board PCBA	1	/
13	043-006119-00	Key seat	1	/
14	043-006004-01	USB cover display(ESM)	2	replace 043-006004-00
15	115-035456-00	22-inch Handle cover assembly	1	Used for N22
	115-035457-00	19-inch handle cover Assembly		Used for N19
16	115-034031-00	Encoder assembly	1	/
17	115-034030-00	Handle（no Encoder/packaging）	1	/
18	043-005871-02	D22 rear housing(ESM)	1	together with 115-045002-01 to replace 043-005871-01
	043-005820-02	D19 rear housing(ESM)		together with 115-045003-01 to replace 043-005820-00
19	043-006465-01	Interface cover silk of display back	1	replace 043-006465-00

8.4 Display Cover Assembly

8.4.1 Exploded View

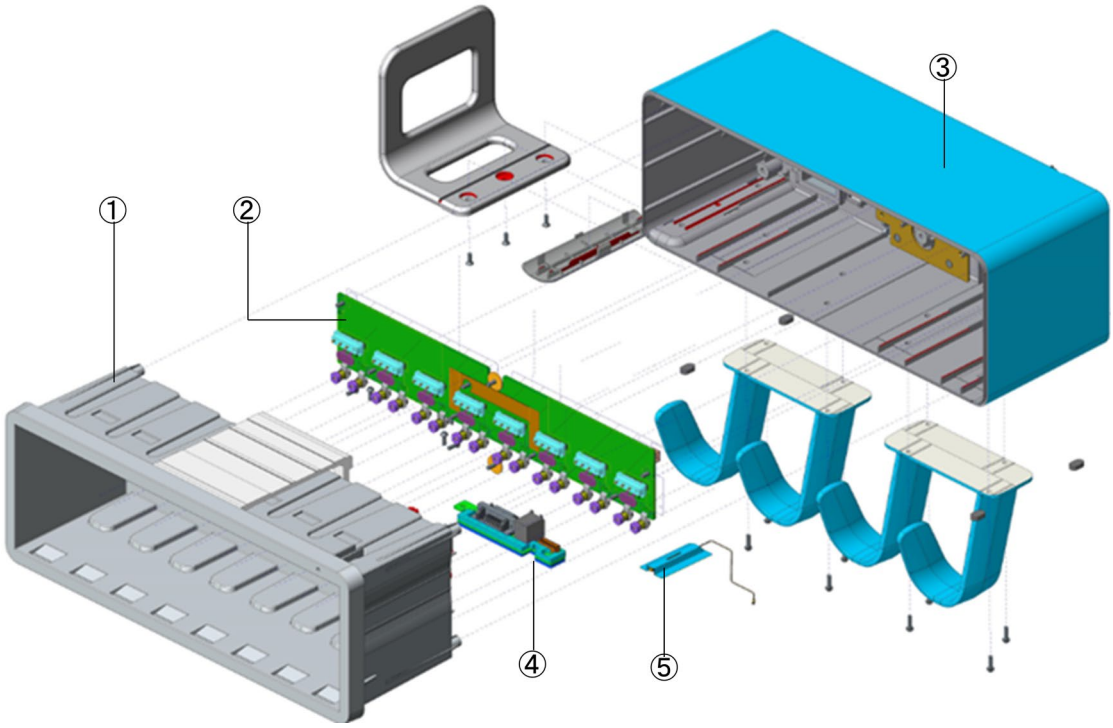


8.4.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	043-008962-00	Cable Management Cover (SilkScreen)	1	/
2	043-006465-01	Interface cover silk of display back	1	replace 043-006465-00
3	051-001916-00	Display Interface Convert Board PCBA	1	/

8.5 Module Rack

8.5.1 Exploded View

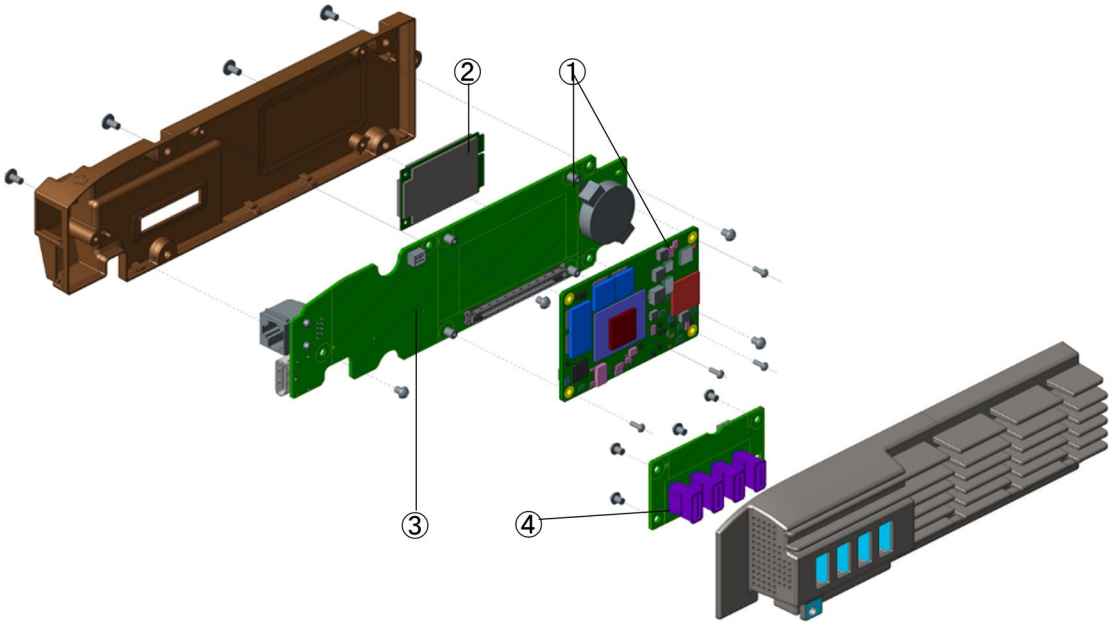


8.5.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	043-008617-00	Front housing silkscreen of module rack(ESM)	1	Replace 043-006301-00
2	115-054923-00	8-slot PCBA of external module rack	1	Replace 115-037493-00
3	043-008616-00	Rear housing silkscreen of module rack(ESM)	1	Replace 043-006300-00
	043-008485-00	The near housing of the SMR（N22N19 neutral）		N22N19 neutral
4	051-001908-00	Interface board PCBA of external module rack	1	/
5	024-000718-00	2.4GHz Antenna of Bluetooth	1	/

8.6 iVIEW Module(Win7/win10 system)

8.6.1 Exploded View

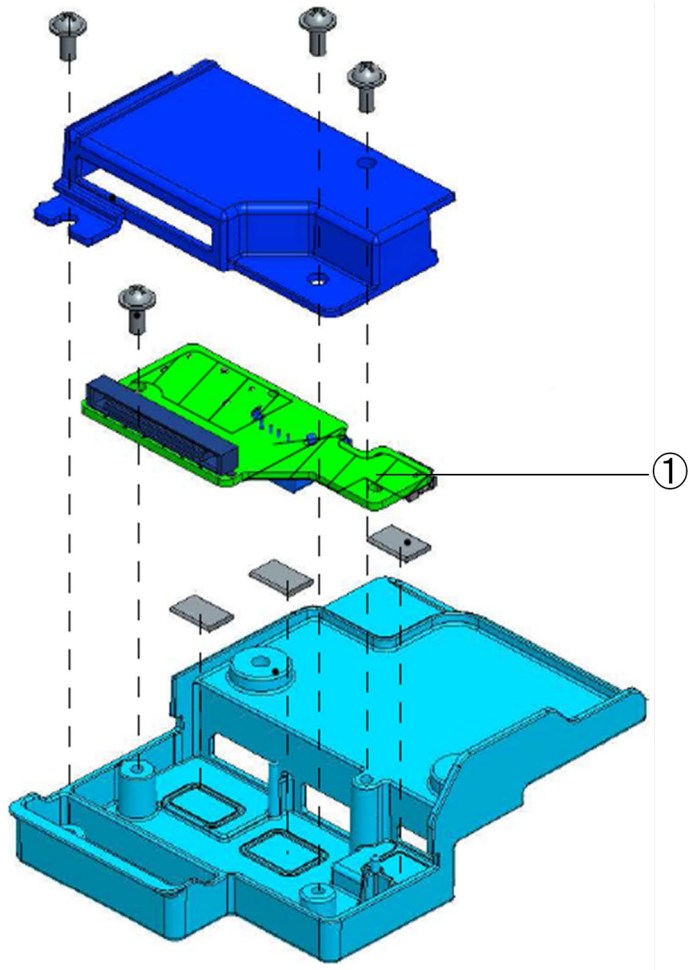


8.6.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	115-056277-00	iView module PCBA FRU	1	used for win7 system, include 051-003028-00 iView support board PCBA (No3)
	115-056280-00	iView module PCBA FRU		used for win10 system, include 051-003028-00 iView support board PCBA (No3)
2	023-000993-00	SSD 120GB mSATA 6Gb/s MLC	1	used for win7 system
	023-001329-00	SSD 128GB MLC mSata		used for win10 system
3	051-001946-00	iView support board PCBA	1	used for win7 system
	051-003028-00	iView support board PCBA		used for win10 system
4	051-001948-00	iView USB interface board PCBA	1	/

8.7 Main Unit Separated Installation Auxiliary Accessories

8.7.1 Exploded View

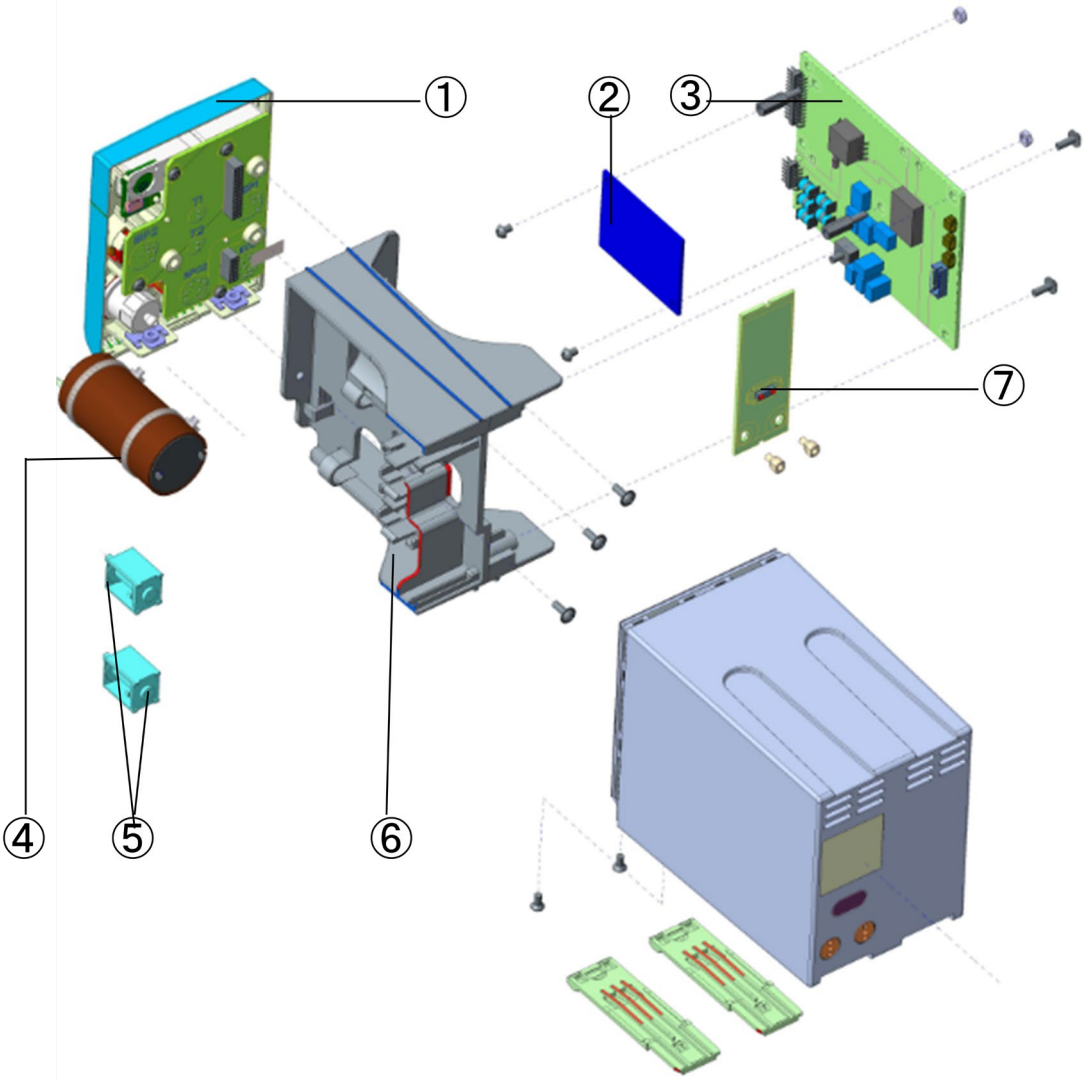


8.7.2 Parts List

No.	Order Number	Part Description	Qty	Remark
1	051-001915-00	Main unit interface adapter board PCBA	1	To be used in separate installation way

8.8 MPM module (M51A)

8.8.1 Exploded View



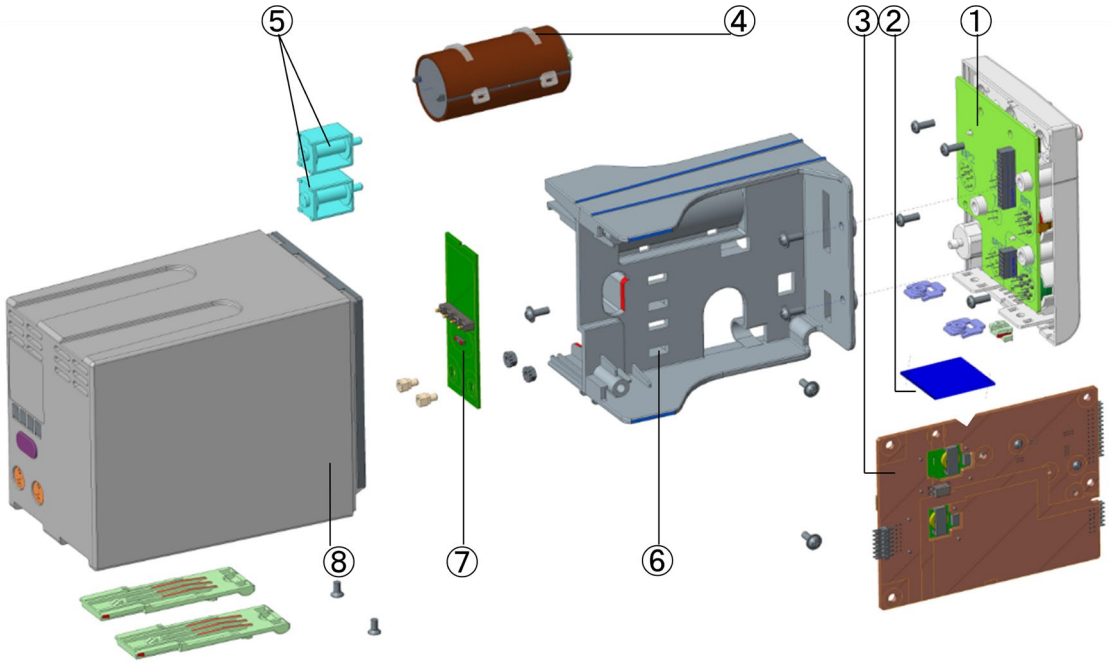
8.8.2 Parts List

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	/

No.	Order Number	Part Description	Qty	Remark
	051-002232-00	M51A multi-parameter module (12 leads, analog output) PCBA	1	/
	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	/

8.9 M51C Module (Platinum)

8.9.1 Exploded View



8.9.2 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)		/

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

8.10 Others

No.	Order Number	Part Description	Qty	Remark
1	009-004998-00	Host to LED Internal power wire	1	cable
2	009-005131-00	display to display interface convert board interconnection line	1	cable
3	009-006879-00	Interconnection line from the display interface board to touchscreen control board	1	cable
4	009-005102-00	main unit to interface convert board interconnection line	1	cable
5	009-005103-00	main unit to display signal cable	1	cable
6	043-005819-00	Protective cable	1	cable
7	115-044675-00	M51C tube accessory(FRU)	1	others
8	044-000785-00	Safety Hook	1	others
9	022-000250-00	Adapter 100-250VAC 12V/5A	1	others
10	100-000173-00	Preamplifier with cable of rSO2 module	1	others
11	009-001770-00	Network cable between benelink module with ID box	1	others
12	115-045621-00	SMR integrated mount accessory Kit	1	others
13	115-033755-00	wifi assembly	/	others
14	115-047640-00	iView package(English/OEM)	/	others
15	115-033904-00	iView system maintenance U disk(WIN7)	/	others
16	115-050029-00	iView system maintenance U disk(WIN10)	/	others
17	115-049986-00	iView upgrade package(EN/WIN10)	/	Upgrade package
18	115-035451-00	separate installation way change to integrated installation way	/	Upgrade package
19	115-051379-00	Together installation chage to separate Package(whirl/ESM)	/	Upgrade package
20	115-049900-00	ID adapter upgrade package (with network cable and F serial cable)	/	Upgrade package
21	115-049179-00	MPM-IBP Upgrade Kit(NC SPO2 3/5 lead)	/	Upgrade package
22	115-049180-00	MPM-IBP Upgrade Kit(MR SPO2 3/5 lead)	/	Upgrade package
23	045-003140-00	BD trolley plate assembly	1	Rolling stand
24	045-003258-00	BD rolling stand maintenance package	1	Rolling stand
25	034-000090-00	caster with a lock	1	Rolling stand
26	043-000383-00	Base cover	1	Rolling stand
27	051-002035-00	Encoder Interface and Key Board PCBA	1	/

FOR YOUR NOTES

9 Disassembly and Repair

9.1 Tools

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

- Phillips screwdrivers
- Tweezers
- Needle nose pliers
- Cutting pliers
- Flat-bladed screwdriver

9.2 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 the battery. Before taking out the battery, remove the main unit housing.

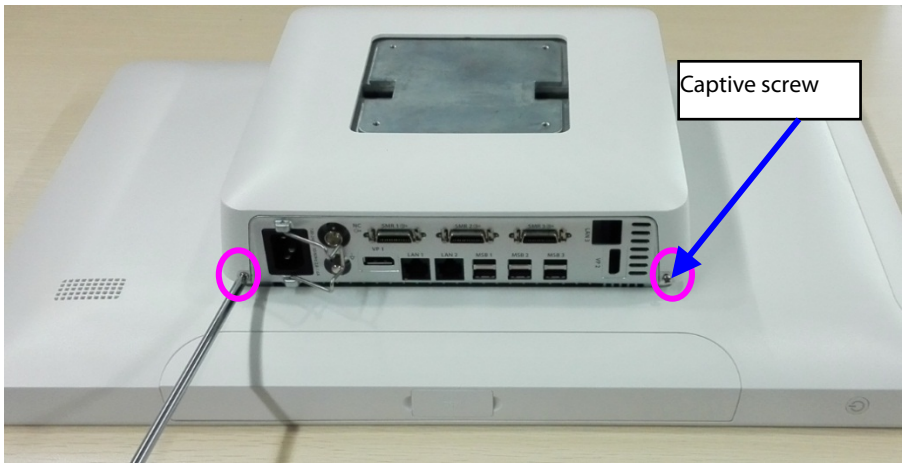
9.3 Whole Unit Disassembly

NOTE

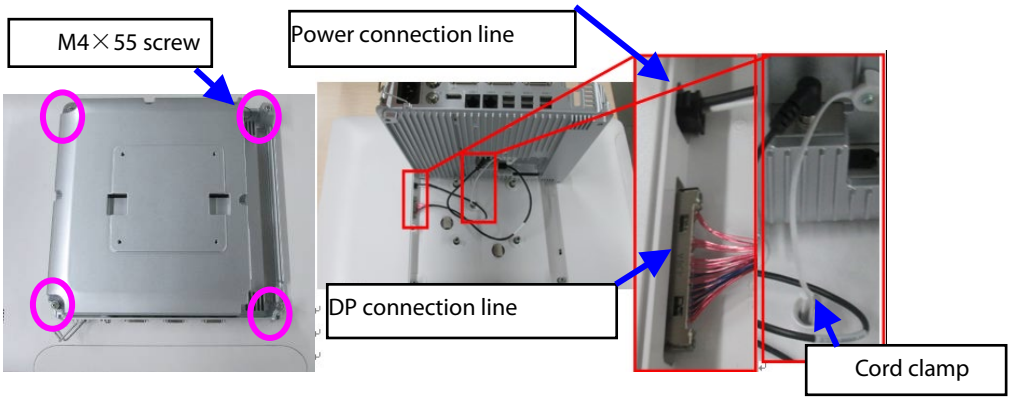
- **Before disassembly, make sure that the point for placement is smooth and free of unrelated things, lest the touchscreen would be scratched.**
- **All the operations must be performed by professionals. Be sure to wear insulating gloves during the repair.**
- **When optional functions are indicated, the related operations may be involved if this function is selected for the machine; otherwise, the related operations are not involved.**

9.3.1 Disassembling Display and Main Unit (Main Unit and Display Integrated Installation)

As shown in the following picture, place the monitor on a desk horizontally, loosen two M3 captive screws, and then lift the main unit housing to get it out.

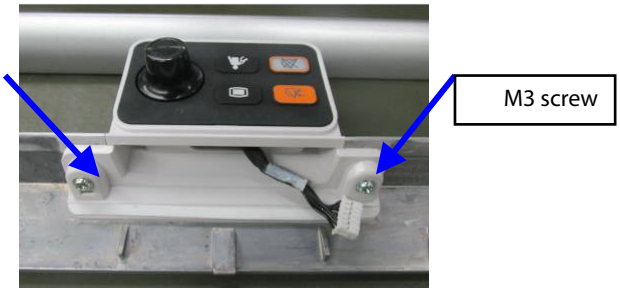


As shown in the following picture, loosen to remove four M4X55 screws, lift the main unit slowly, unplug the DP connection line, power connection line and cord clamp, and separate the main unit from the display.



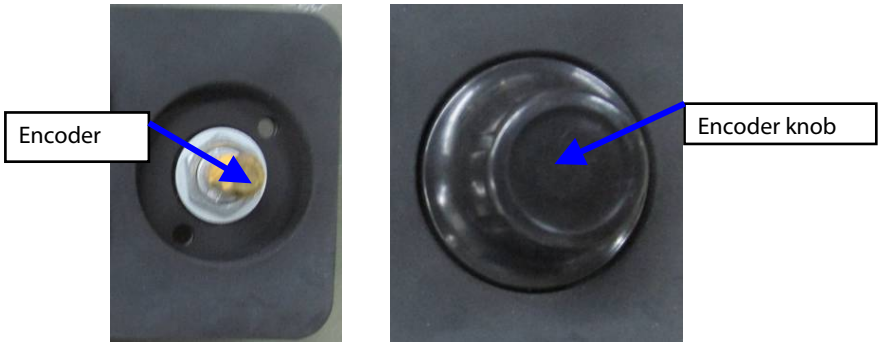
9.3.2 Removing Handle/Encoder (Optional Encoder)

As shown in the following picture, loosen two captive screws, unplug the encoder connection line, and take out the handle assembly; loosen and remove the M3X6 cross recessed pan head screws with pad, and take out the encoder assembly.



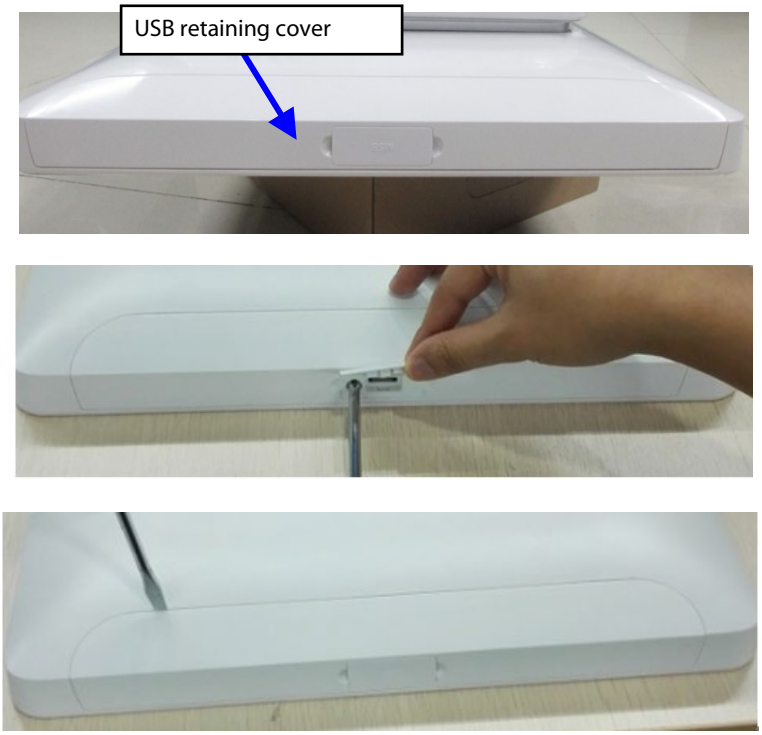
As shown in the following picture, loosen and remove the two M3X6 cross recessed pan head screws with pad, and take out the keypad board assembly; then, unplug the connection line, loosen and remove the cross recessed pan head screws with pad, and take out the encoder assembly.

As shown in the following picture, use a tool to push out the encoder knob from the small hole, use a pair of needle nose pliers to loosen the encoder nut, and take out the encoder.



9.3.3 Removing Handle Cover

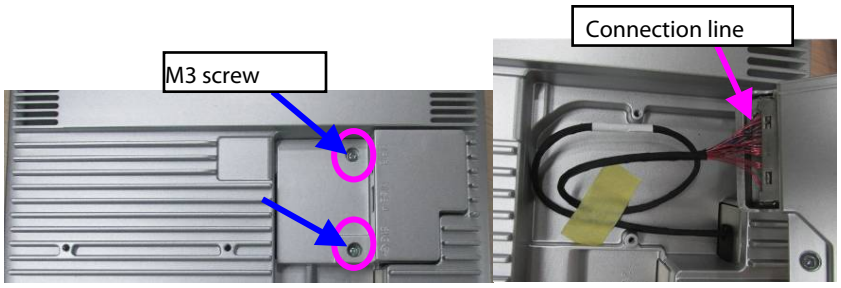
As shown in the following picture, place the monitor on a desk horizontally, unbuckle the USB retaining cover, loosen and remove one M3X6 screw, and then take out the handle cover.



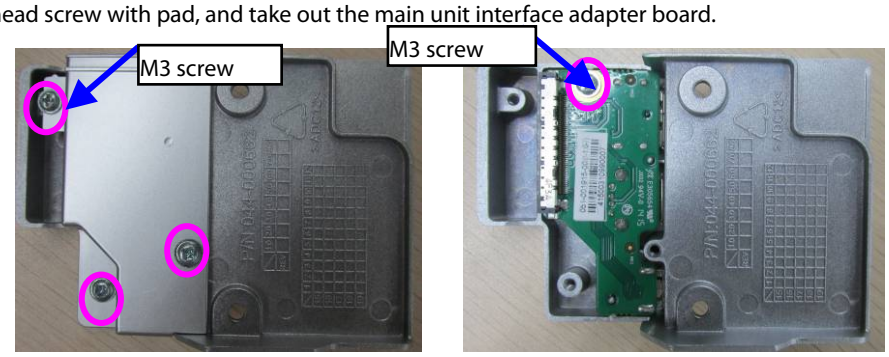
9.3.4 Removing Main Unit Housing/Main Unit Interface Adapter Board (Main Unit and Display Separated Installation)

As shown in the following picture, place the monitor on a desk horizontally, loosen two M3 captive screws, and then lift the main unit housing to get it out.

As shown in the following picture, place the monitor on a desk with upside down, loosen and remove the two M3X6 cross recessed pan head screws with pad, unplug the connection line, and take out the cover for separated installation adapter of main unit.

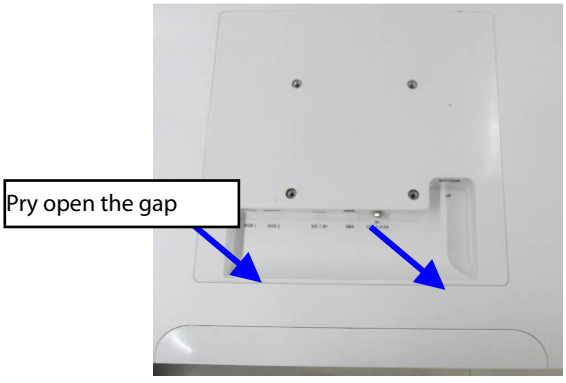


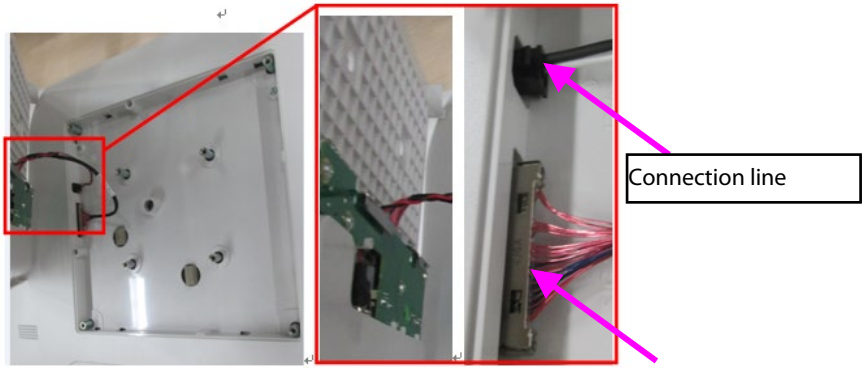
As shown in the following picture, loosen and remove the three M3X6 cross recessed pan head screws with pad, and remove the adapter board cover of main unit; loosen and remove one M3X6 cross recessed pan head screw with pad, and take out the main unit interface adapter board.



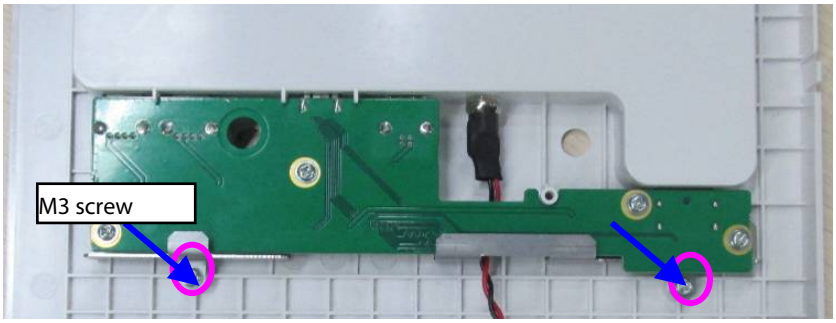
9.3.5 Removing Display Interface Adapter Board (Main Unit and Display Separated Installation)

As shown in the following picture, use a flat-bladed screwdriver to pry open the display adapter cover plate, unplug the power connection line and DP connection line, and take out the display interface cover plate.





As shown in the following picture, loosen and remove the two M3X6 cross recessed pan head screws with pad, and take out the display interface adapter board.



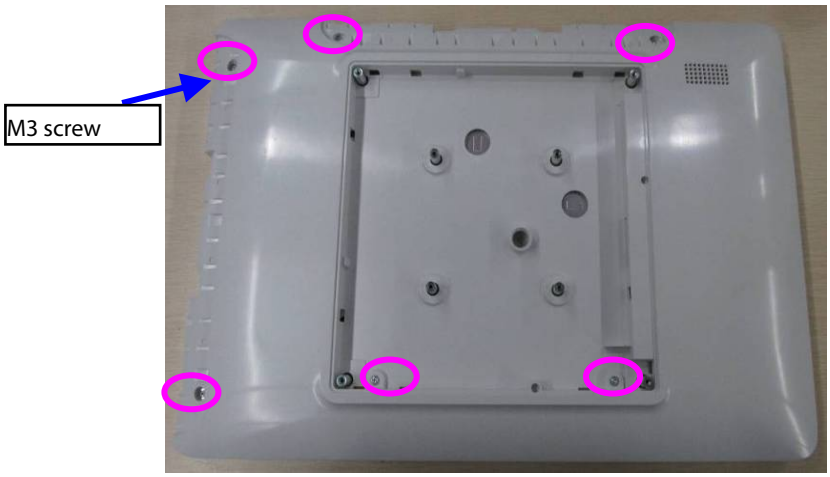
9.4 Disassembling Display (Resistive Touchscreen)

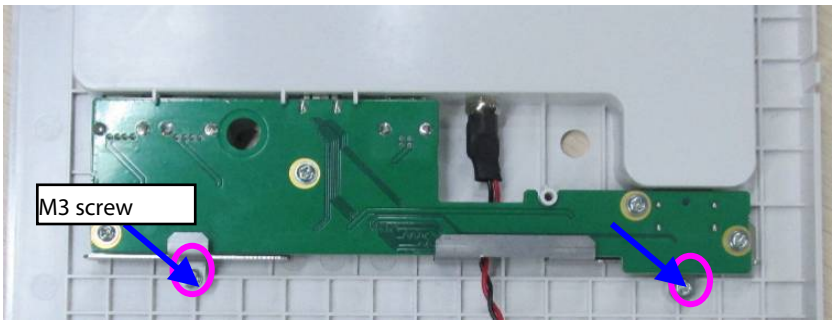
NOTE

- **Before disassembly, make sure that the point for placement is smooth and free of unrelated things, and pave foam or similar material under the display, lest the touchscreen would be scratched.**
- **When optional functions are indicated, the related operations may be involved if this function is selected for the machine; otherwise, the related operations are not involved.**

9.4.1 Removing Display Rear Housing Assembly (D19)

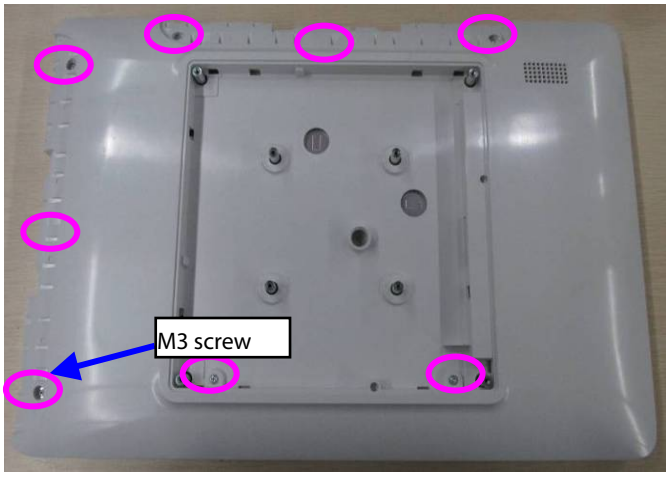
As shown in the following picture, loosen and remove the six M3X6 cross recessed pan head screws with pad.





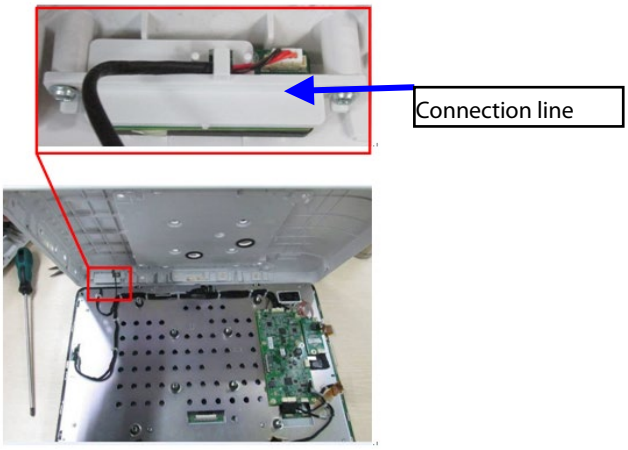
9.4.2 Removing Display Rear Housing Assembly (D22

As shown in the following picture, loosen and remove the eight M3X6 cross recessed pan head screws with pad.

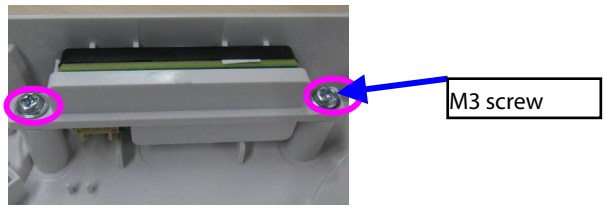


9.4.3 Removing Switch Keypad Board

As shown in the following picture, unplug the connection line of switch keypad board.

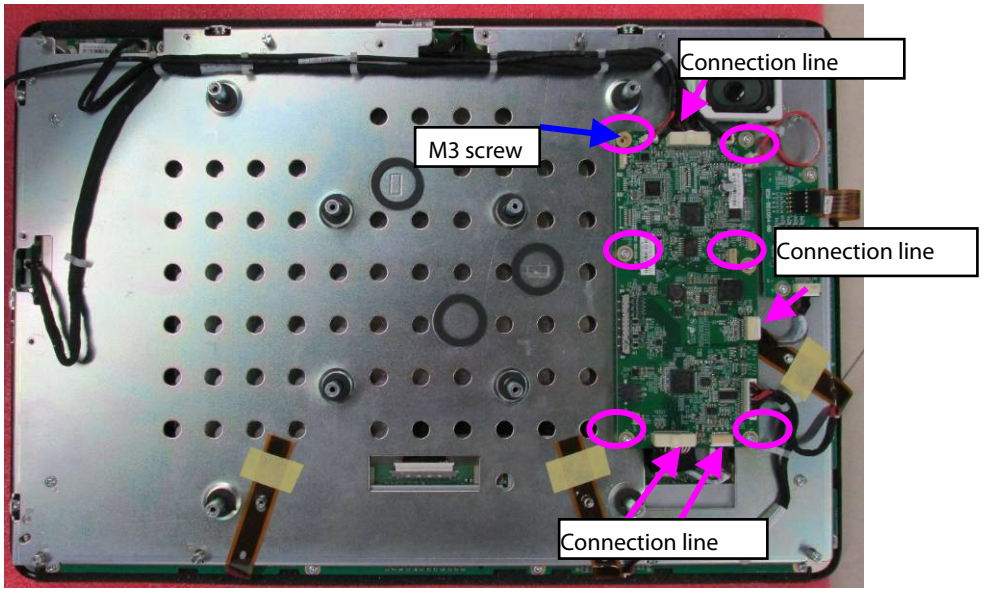


As shown in the following picture, loosen and remove the two M3X6 cross recessed pan head screws with pad, and take out the switch keypad board assembly.

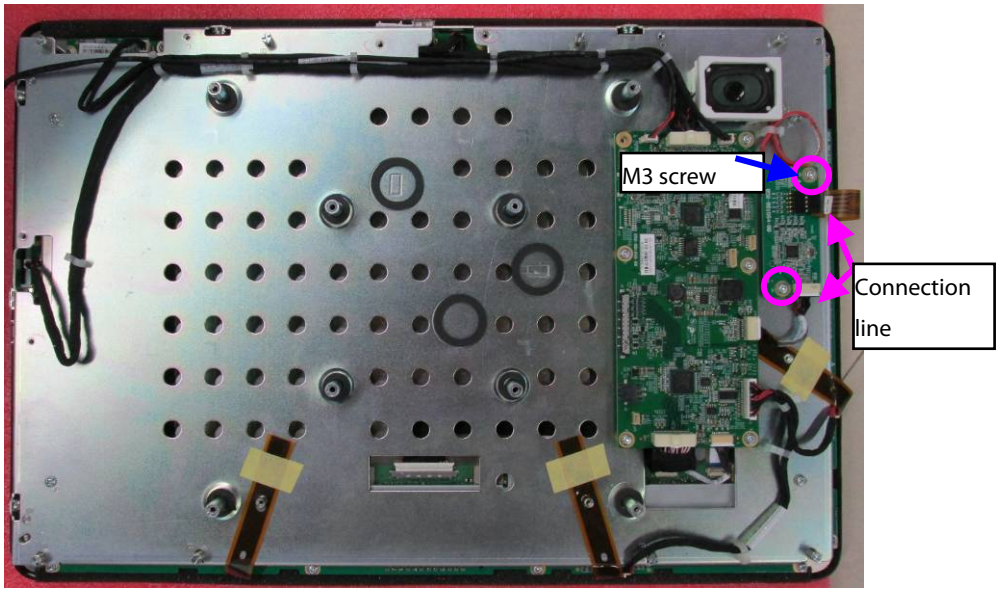


9.4.4 Removing Display Interface Board/Touchscreen Panel

As shown in the following picture, loosen and remove the six M3X6 cross recessed pan head screws with pad, unplug the connection line, and take out the display interface board.

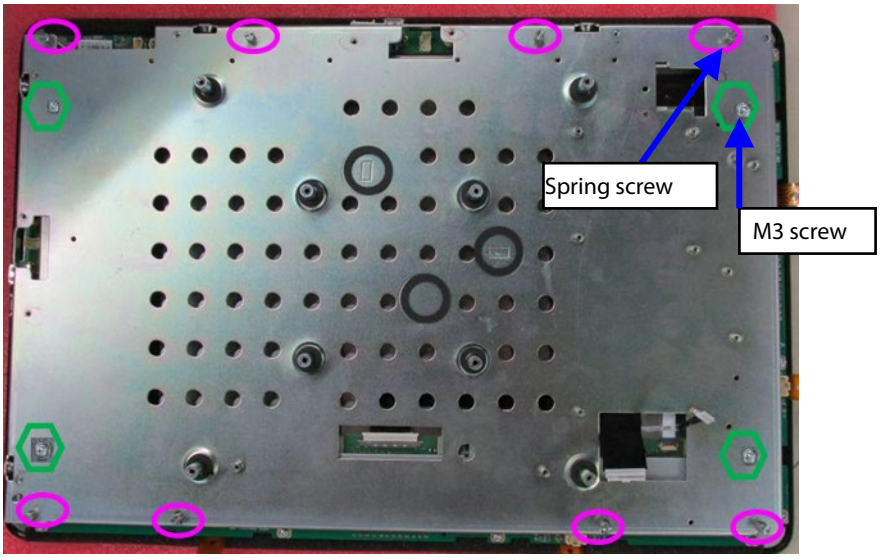


As shown in the following picture, unplug the touchscreen line, loosen and remove the two M3X6 cross recessed pan head screws with pad, and take out the touchscreen panel.

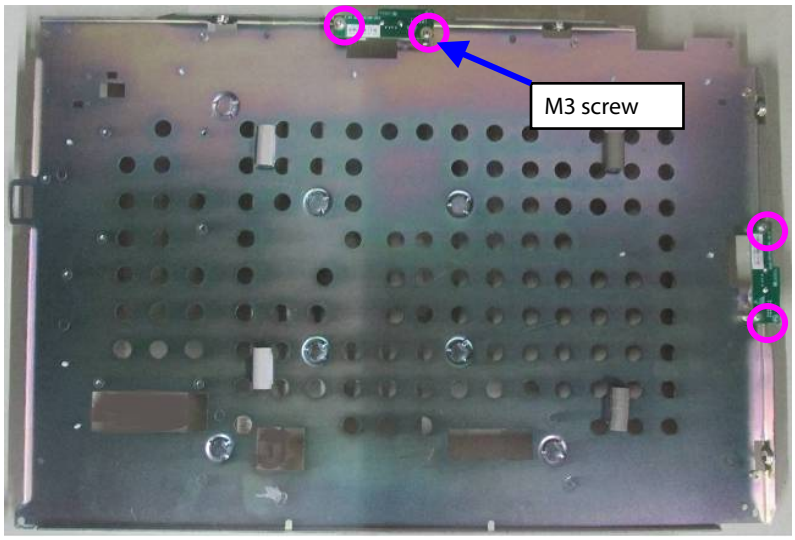


9.4.5 Removing USB Board

As shown in the following picture, loosen and remove the eight spring screws and four M3X6 cross recessed pan head screws with pad, and take out the main bracket.

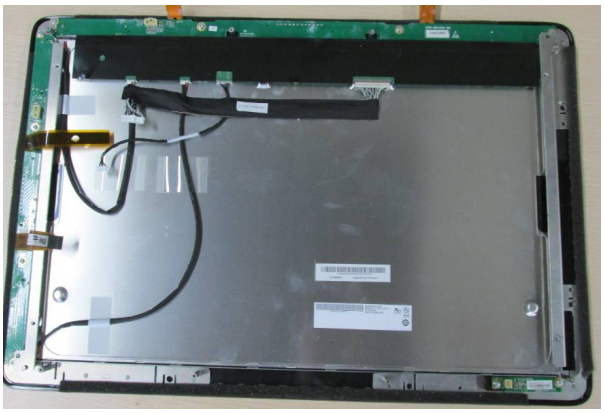


As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, and take out the USB board.

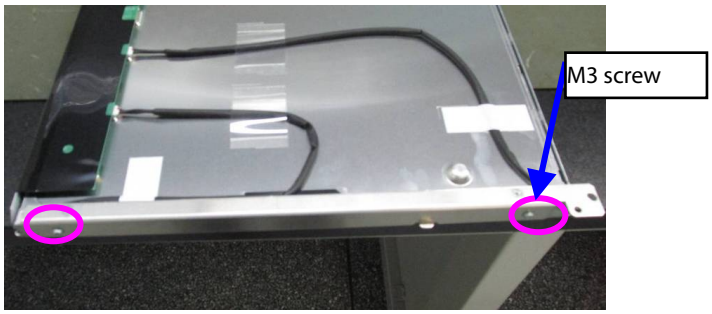


9.4.6 Removing Display Screen

As shown in the following picture, take the display screen assembly out of the touchscreen assembly.



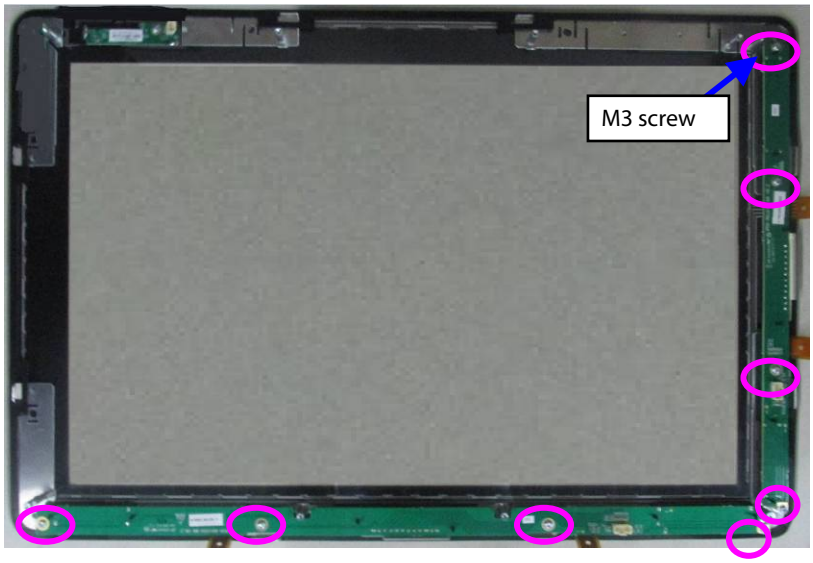
As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad at two sides, and take out the display screen.



9.4.7 Removing LED Board/Indicator Board

As shown in the following picture, loosen and remove the two M3X6 cross recessed pan head screws with pad, and take out the indicator board.

As shown in the following picture, loosen and remove the eight M3X6 cross recessed pan head screws with pad, and take out the LED board.



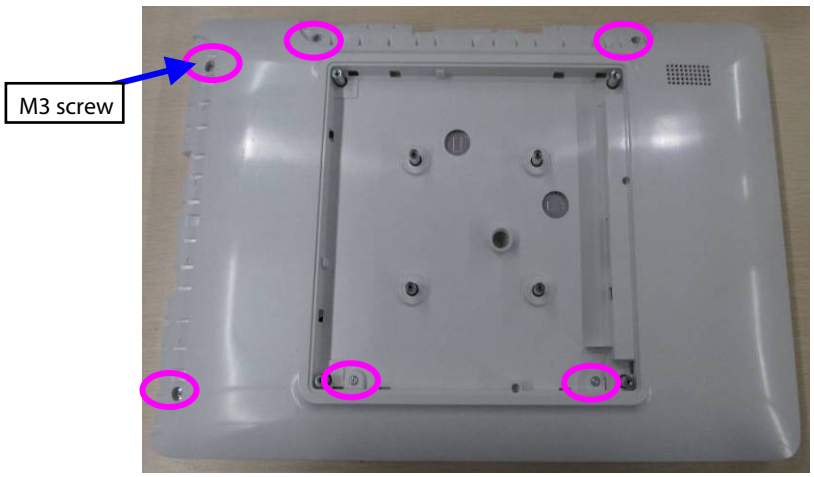
9.5 Disassembling Display (Capacitive Touchscreen)

NOTE

- **Before disassembly, make sure that the point for placement is smooth and free of unrelated things, and pave foam or similar material under the display, lest the touchscreen would be scratched.**
- **When optional functions are indicated, the related operations may be involved if this function is selected for the machine; otherwise, the related operations are not involved.**

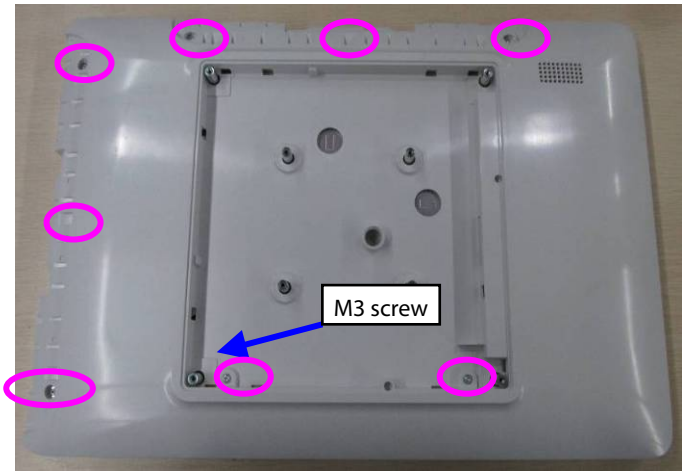
9.5.1 Removing Display Rear Housing Assembly (D19)

As shown in the following picture, loosen and remove the six M3X6 cross recessed pan head screws with pad.



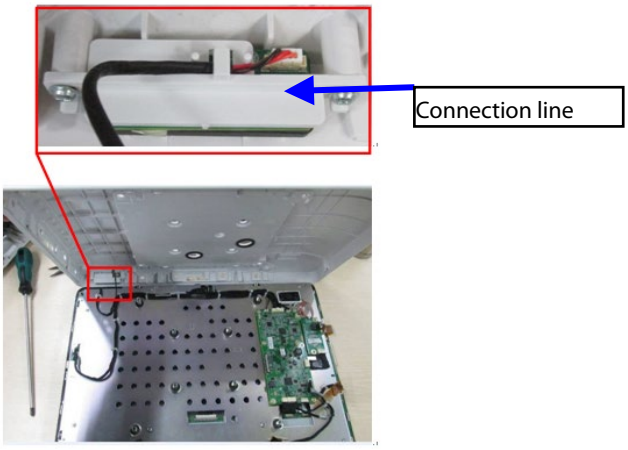
9.5.2 Removing Display Rear Housing Assembly (D22)

As shown in the following picture, loosen and remove the eight M3X6 cross recessed pan head screws with pad.

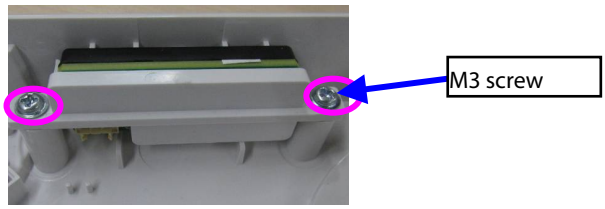


9.5.3 Removing Switch Keypad Board

As shown in the following picture, unplug the connection line of switch keypad board.

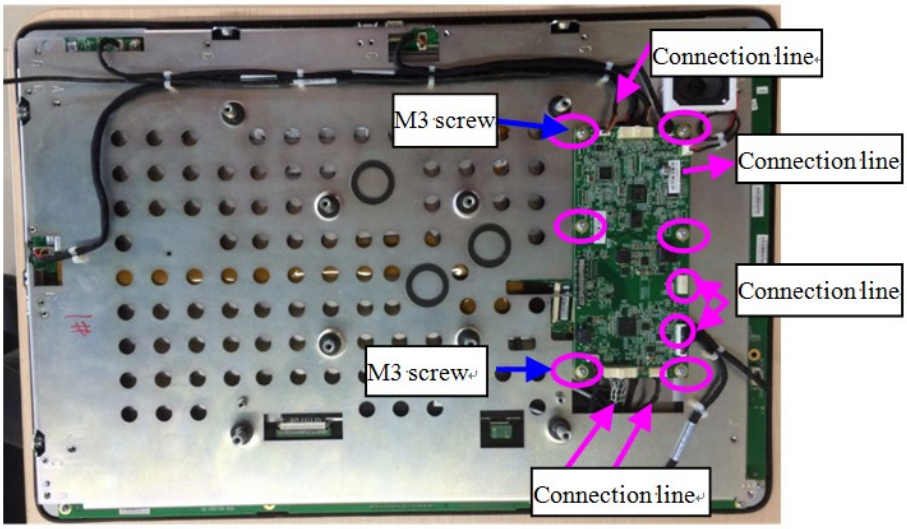


As shown in the following picture, loosen and remove the two M3X6 cross recessed pan head screws with pad, and take out the switch keypad board assembly.



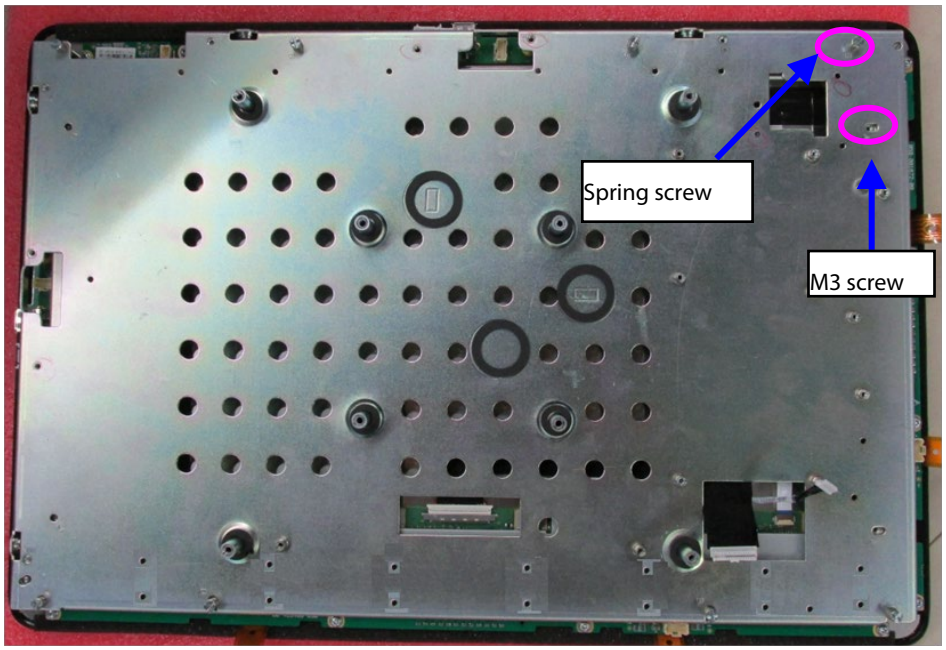
9.5.4 Removing Display Interface Board/Touchscreen Panel

As shown in the following picture, loosen and remove the six M3X6 cross recessed pan head screws with pad, unplug the connection line, and take out the display interface board.

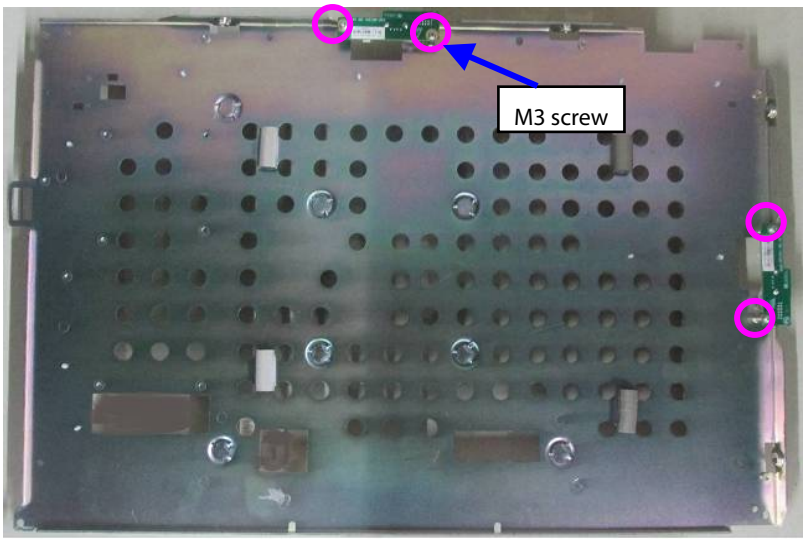


9.5.5 Removing USB Board

As shown in the following picture, loosen and remove the four spring screws and four M3X6 cross recessed pan head screws with pad, and take out the main bracket.



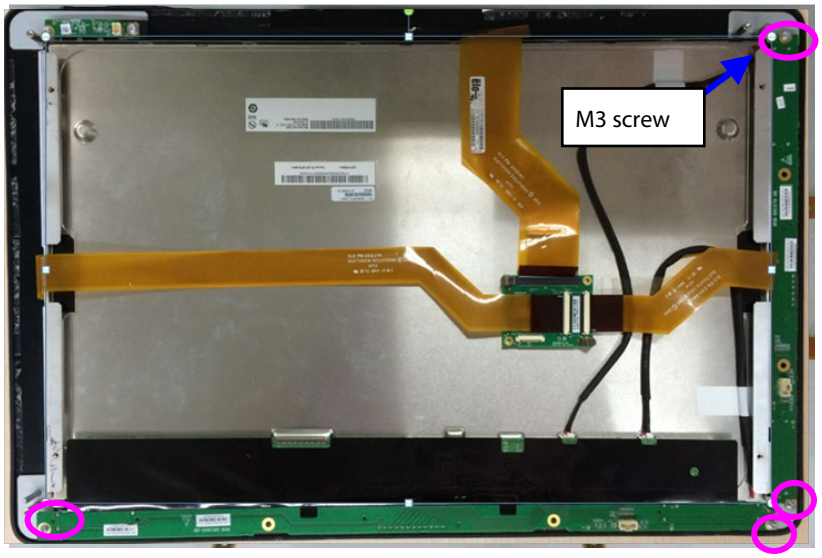
As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, and take out the USB board.



9.5.6 Removing LED Board/Indicator Board

As shown in the following picture, loosen and remove the two M3X6 cross recessed pan head screws with pad, and take out the indicator board.

As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, and take out the LED board.



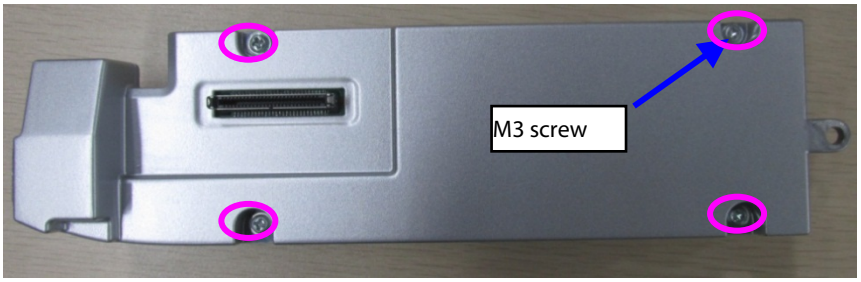
9.6 Disassembling Main Unit

9.6.1 Removing iView Assembly (iView Assembly Optional)

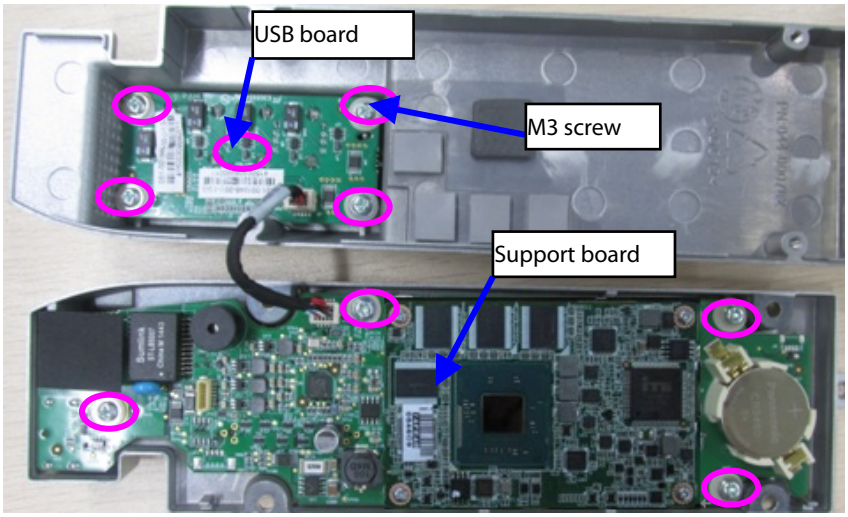
As shown in the following picture, loosen and remove the two M3X6 cross recessed pan head screws with pad, and take out the iView assembly.

9.6.2 Removing iView Assembly Support Board/USB Interface Board (iView Assembly Optional)

As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, and take out the iView assembly.

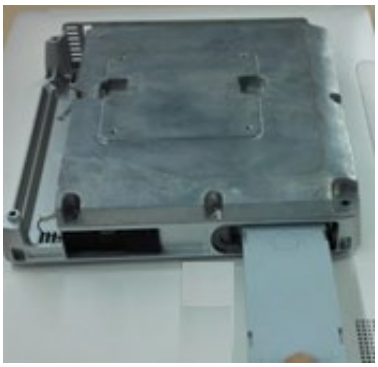


As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, and take out the USB board; remove the four M3X6 cross recessed pan head screws with pad, and take out the support board.



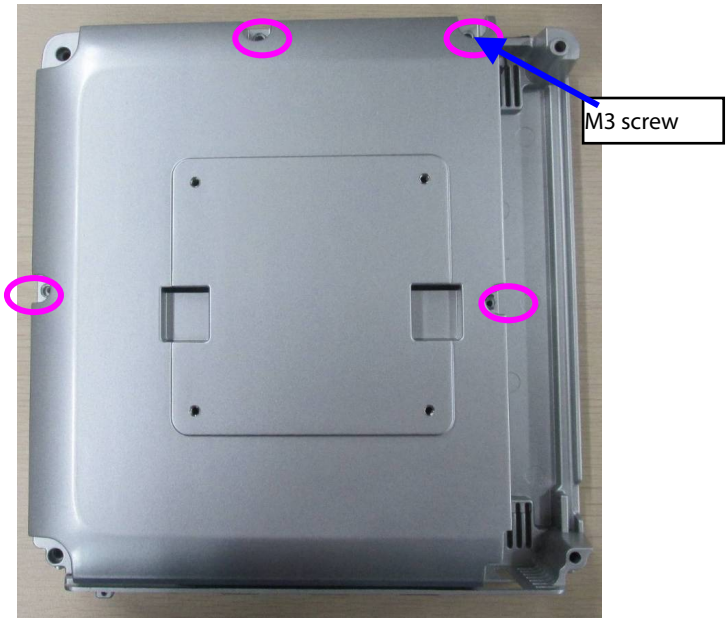
9.6.3 Removing Battery

As shown in the following picture, use a flat-bladed screwdriver to take out the battery cover, and then take out the battery.

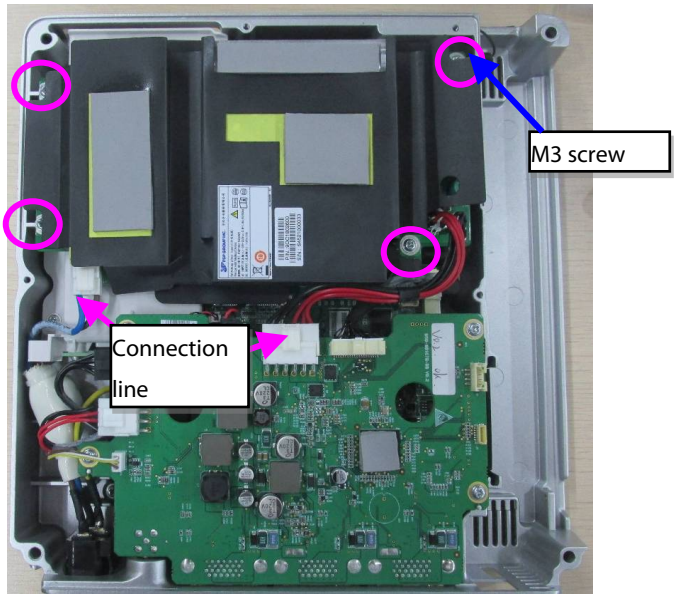


9.6.4 Removing ACDC Power Board

As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, and remove the upper cover of main unit.

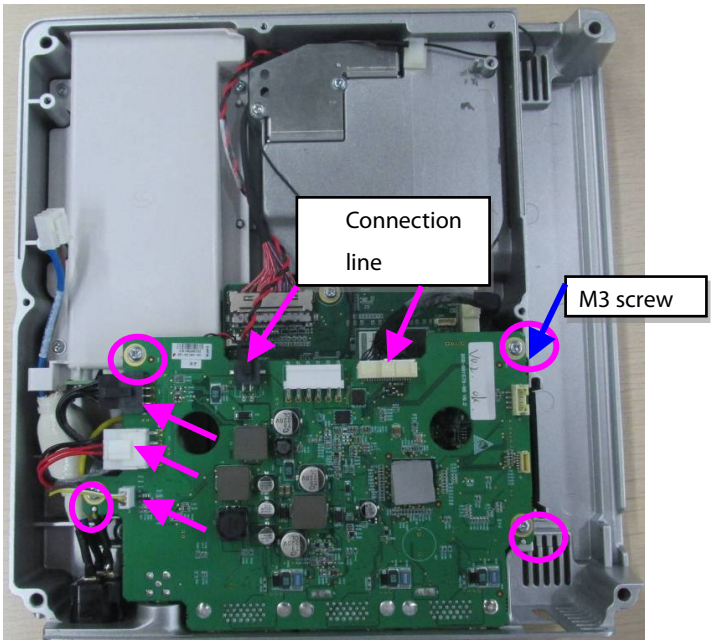


As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, unplug the power connection line, and take out the ACDC power board.

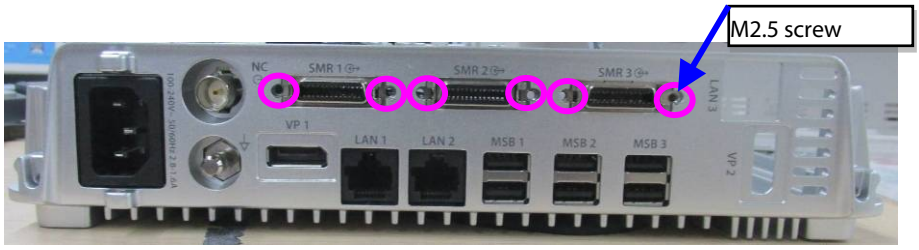


9.6.5 Removing DCDC Power Management Board

As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, and unplug the power connection line.

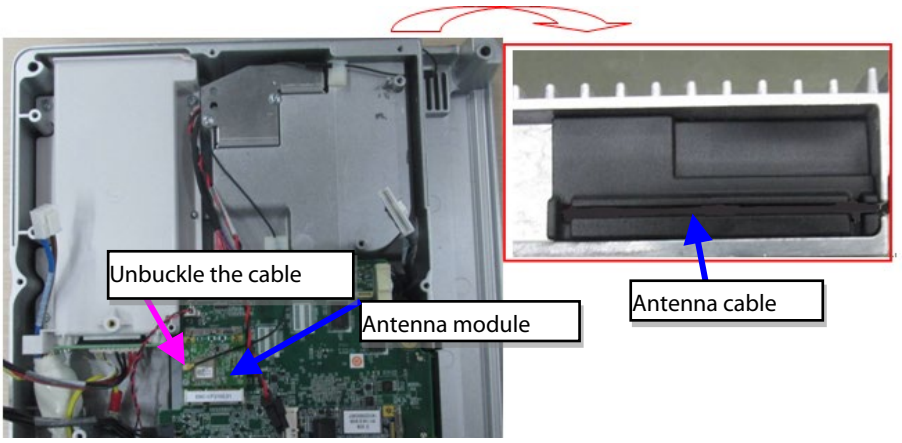


As shown in the following picture, loosen and remove the six small M3X6 pan head screws, and take out the DCDC power management board.



9.6.6 Removing Antenna Module and Antenna Cable

As shown in the following picture, unbuckle the antenna connection line, and take out the antenna module and antenna cable.

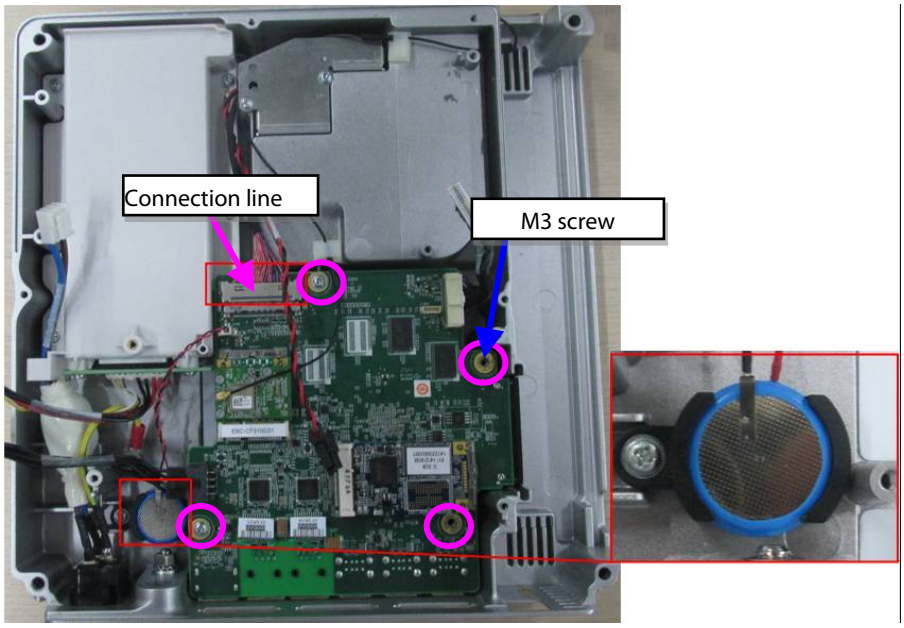


9.6.7 Removing SSD Hard Disk

As shown in the following picture, take out the SSD hard disk.

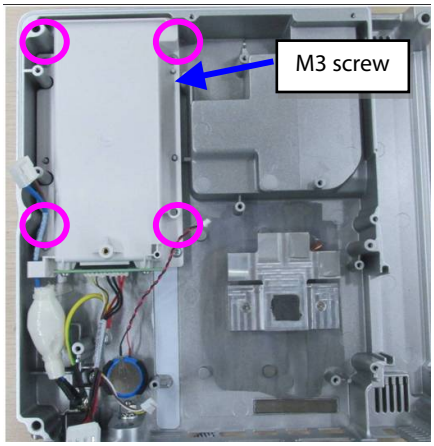
9.6.8 Removing Main Control Board

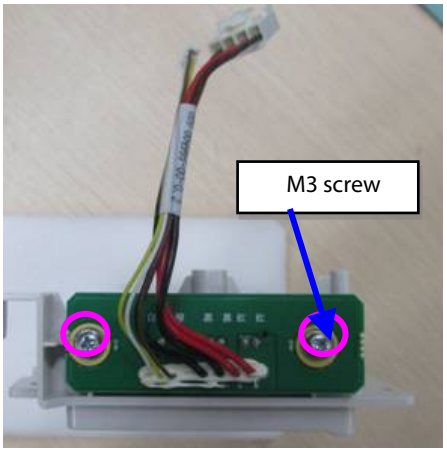
As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, unbuckle the button battery, and take out the main control board.



9.6.9 Removing Battery Backplane

As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, and take out the battery cavity assembly; remove the two M3X6 cross recessed pan head screws with pad, and take out the battery backplane.

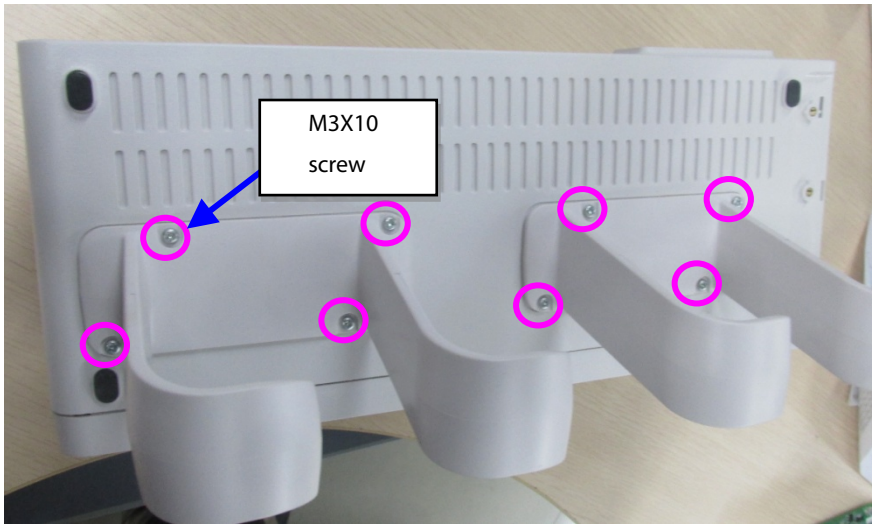




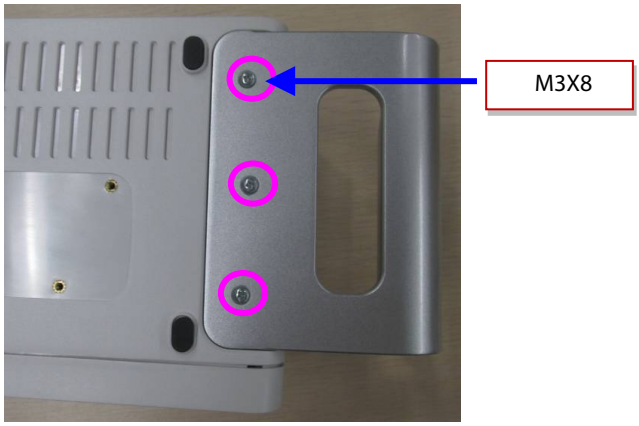
9.7 Disassembling the Module Rack

9.7.1 Disasembling 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.

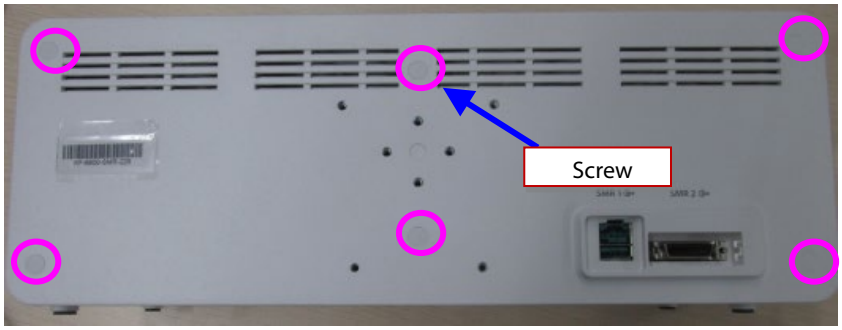


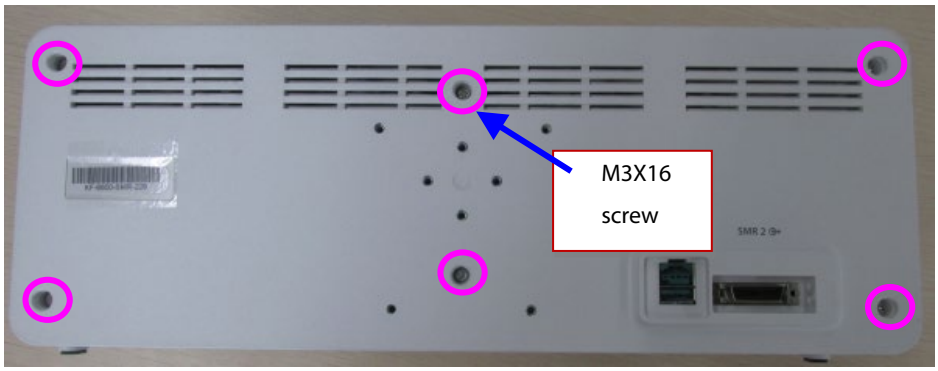
As shown in the following figure, loosen and remove the three M3×8 cross recessed countersunk head screws, and remove the handle.



9.7.2 Disassembling the Rear Case of Module Rack

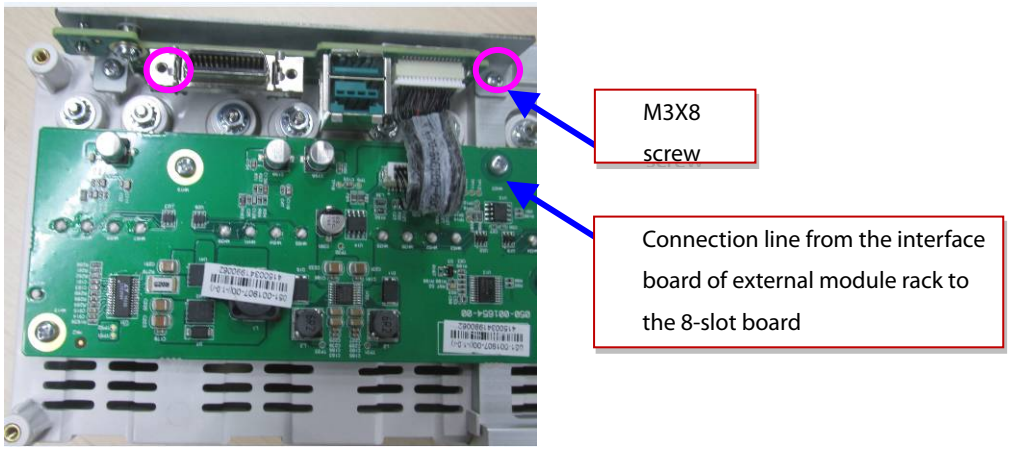
As shown in the following figure, use a tweezer to take out the six screw covers on the rear case, loosen and remove the six M3X16 cross recessed pan head screw, and separate the front case from the rear case.





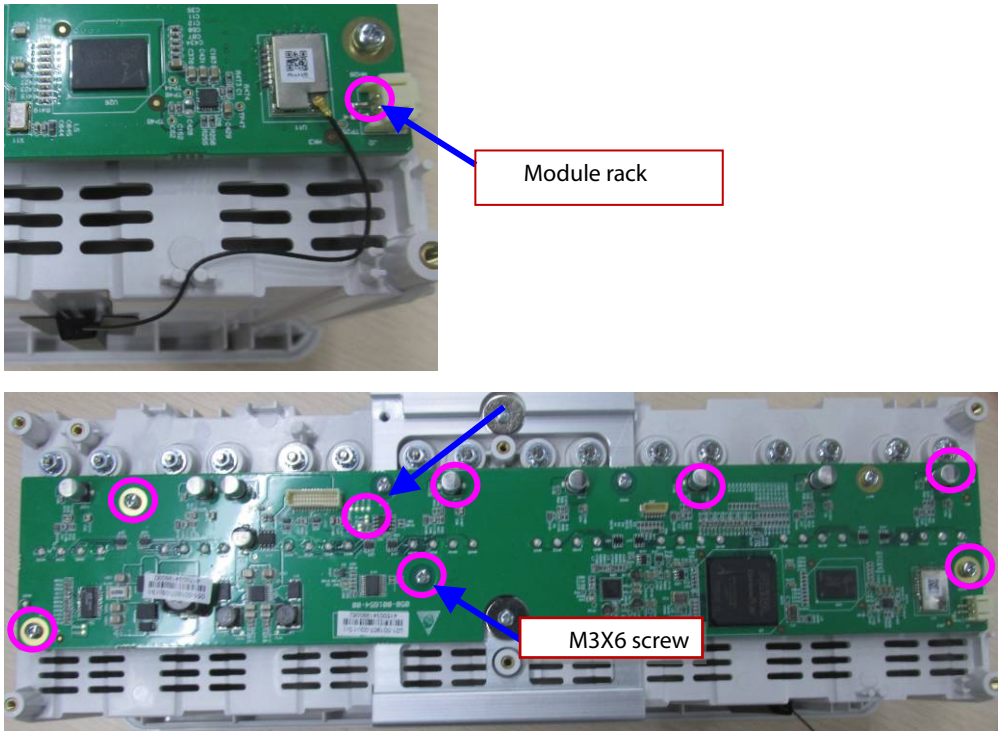
9.7.3 Disassembling the Module Rack Interface Board

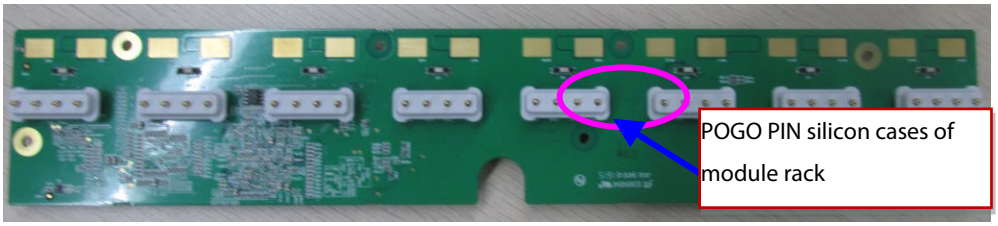
Loosen and remove the two M3X8 cross recessed pan head screws, pull out the connection line between the interface board and the infrared backplane, and then take out the interface board.



9.7.4 Disassembling the Infrared Backplane of Module Rack

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

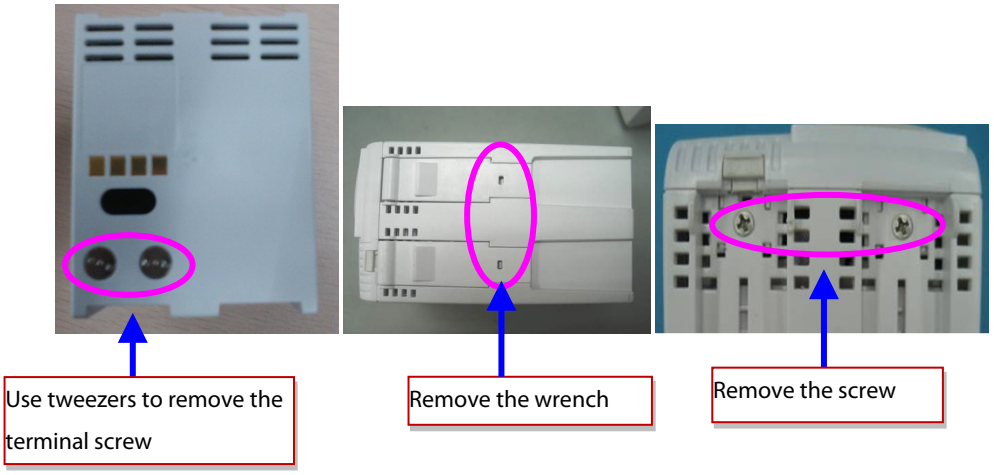




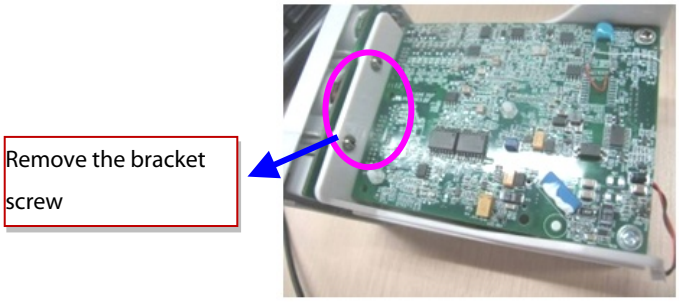
9.8 Disassembling the M51C Module

9.8.1 Disassembling the Front Panel Assembly

As shown in the figure, use 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.

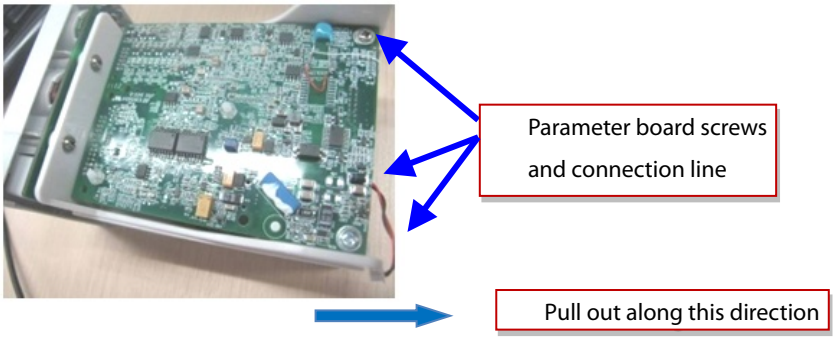


As shown in the following figure, loosen and remove the screw between the front panel and the bracket, and unplug the air tube at the air nozzle. Then the front panel can be removed.



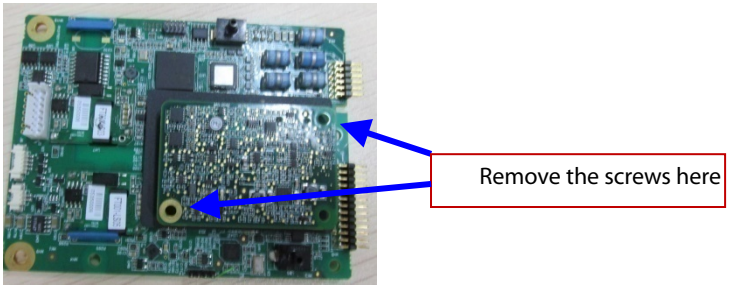
9.8.2 Disassembling the Parameter Board

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.



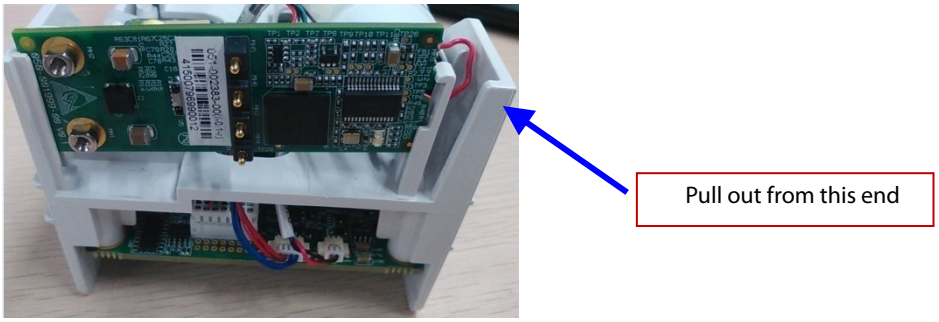
9.8.3 Disassembling the SpO_2 board

As shown in the following figure, remove the SpO_2 board screws, and then pull out the blood oxygen board.



9.8.4 Disassembling the Infrared Board

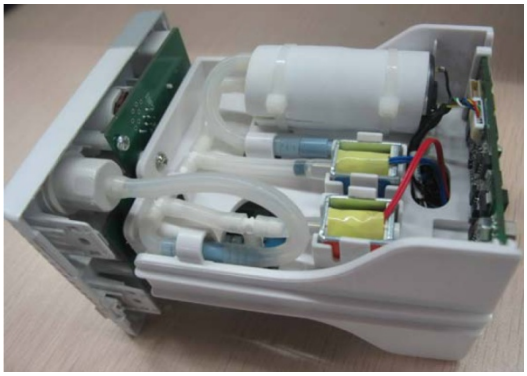
As shown in the following figure, remove the infrared board connection line, and then remove the infrared board.

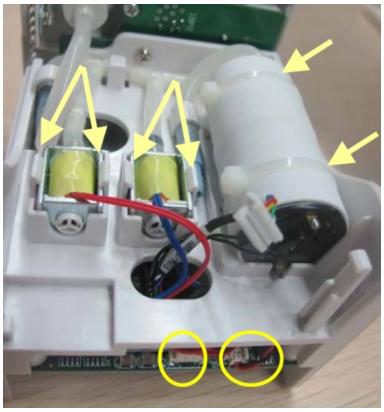


9.8.5 Removing the Pump and Valve

Cut off the cable tie, unplug the pump power line and NIBP air tube, and then remove the pump.

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

A Electrical Safety Inspection

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

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

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

A.1 Power Cord Plug

A.1.1 The Power Plug

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

A.2 Device Enclosure and Accessories

A.2.1 Visual Inspection

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

A.2.2 Contextual Inspection

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

A.3 Device Labeling

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

- Main unit label
- Integrated warning labels

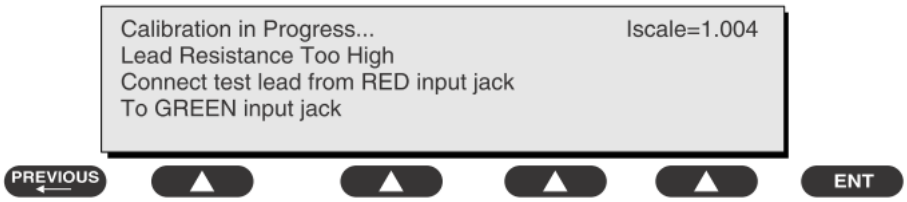
A.4 Protective Earth Resistance

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

The following conditions apply: L1 and L2 Open.

Preparation

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



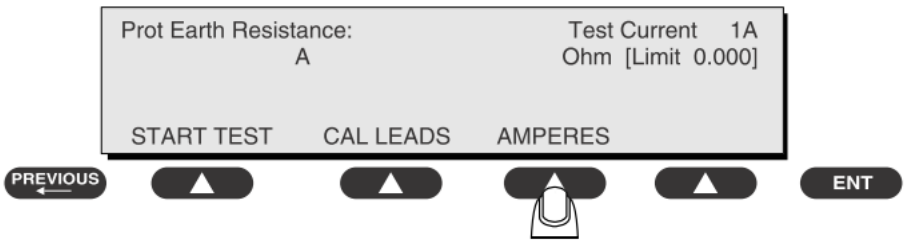
If the calibration fails, the previously stored readings will be used until a passing calibration has occurred.:

⚠WARNING

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

To Perform the Test

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



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

NOTE

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

In Case of Failure

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

LIMITS

ALL COUNTRIES R = 0.2 Ω Maximum

A.5 Earth Leakage Test

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

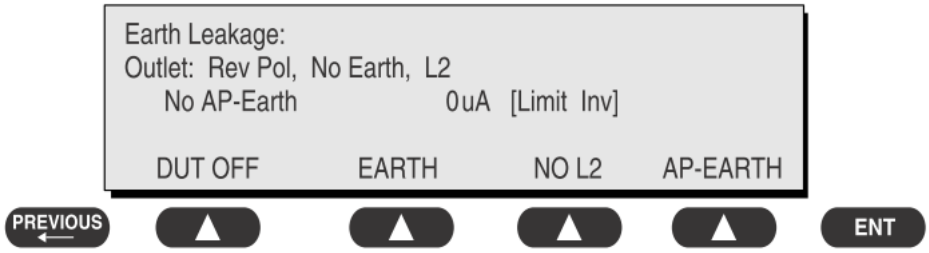
Leakage current is measured the following ways:

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

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

To Perform the Test

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



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

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

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

In Case of Failure

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

LIMITS

For IEC60601-1,

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

A.6 Patient Leakage Current

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

Preparation

Perform a calibration from the Mains on Applied Part menu.

The following outlet conditions apply when performing this test:

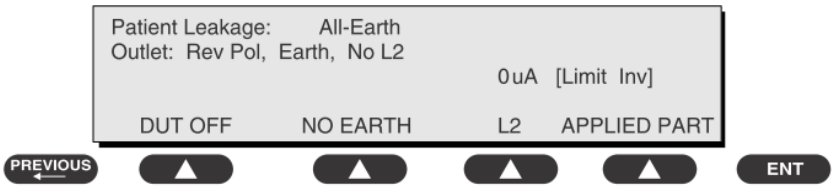
- Normal Polarity, Earth Open, Outlet ON Normal Polarity, Outlet ON
- Normal Polarity, L2 Open, Outlet ON Reversed Polarity, Outlet ON
- Reversed Polarity, Earth Open, Outlet ON Reversed Polarity, L2 Open, Outlet ON

⚠WARNING

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

To Perform the Test

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



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

In Case of Failure

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

LIMITS

For CF  applied parts

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

For BF  applied parts

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

A.7 Mains on Applied Part Leakage

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

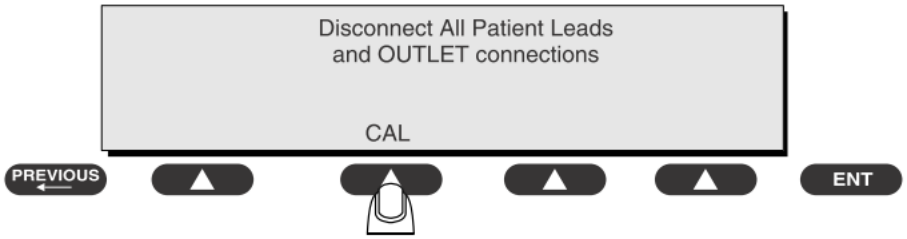
The following outlet conditions apply when performing the Mains on Applied Part test.

- Normal Polarity;
- Reversed Polarity

Preparation

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

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



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

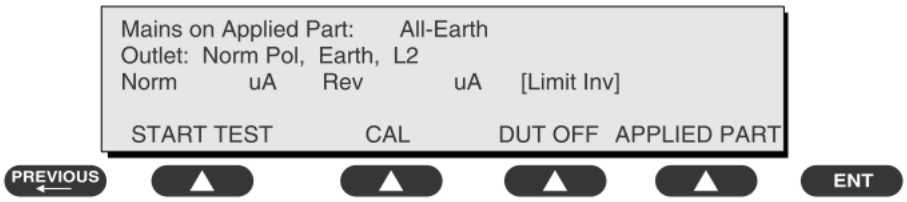
3. When the calibration is finished, the Mains on Applied Part test will reappear.

⚠WARNING

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

To Perform the Test

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



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

NOTE

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

In Case of Failure

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

LIMITS

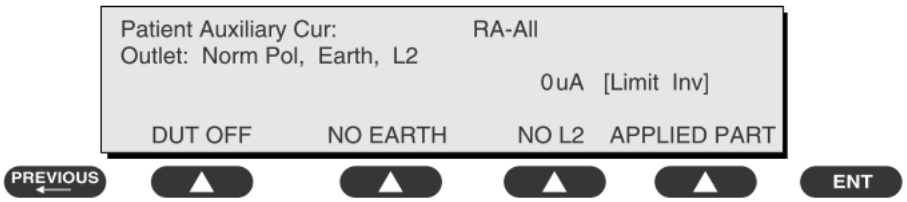
- For CF applied parts: 50 µA
- For BF applied parts: 5000 µA

A.8 Patient Auxiliary Current

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

Preparation

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



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

In Case of Failure

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

LIMITS

For CF  applied parts,

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

For BF  applied parts,

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

A.9 Scheduled Electrical Safety Inspection

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
When both power supply PCBA and patient electrically-connected PCBA are repaired or replaced	Test items: 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:_____

A.10 Electrical Safety Inspection after Repair

The following table specifies test items to be performed after the equipment is repaired.Repair with main unit not disassembled		Test items: 1, 2, 3
Repair with main unit disassembled	When neither power supply PCBA nor patient electrically-connected PCBA is repaired or replaced	Test items: 1, 2, 3, 4
	When power supply PCBA is repaired or replaced	Test items: 1, 2, 3, 4, 5
	When patient electrically-connected PCBA is repaired or replaced	Test items: 1, 2, 3, 4, 6, 7, 8
	When both power supply PCBA and patient electrically-connected PCBA are repaired or replaced	Test items: 1, 2, 3, 4, 5, 6, 7, 8

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