

BeneVision N22/BeneVision N19

Patient Monitor

Service Manual

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Release time: January 2019

Revision 5.0

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WARNING

- **Federal Law (USA) restricts this device to sale by or on the order of a physician or other practitioner licensed by U.S. state law to use or order the use of this device.**
-

NOTE

- **This manual describes all features and options. The equipment may not have all of them. Contact Mindray Technical Support department for any questions.**
-

Manufacturer's Responsibility

Contents of this manual are subject to changes without prior notice.

Mindray is responsible for safety, reliability and performance of this product only on the condition that:

- All installation operations, expansions, changes, modifications and repairs of this product are conducted by Mindray authorized personnel;
- The electrical installation of the relevant room complies with the applicable national and local requirements;
- This product is operated under strict observance of the operator's manual.

Return Policy

In the event that it becomes necessary to return a unit to Mindray, follow the instructions below.

1. Obtain a return authorization.

Contact the Mindray Service Department and obtain a Mindray Customer Service Authorization Number. The Mindray Customer Service Authorization Number must appear on the outside of the shipping container. Return shipments will not be accepted if the Mindray Customer Service Authorization Number is not clearly visible. Please provide the model number, serial number, and a brief description of the reason for return.

2. Freight policy

The customer is responsible for freight charges when this product is shipped to Mindray for service (including any relevant customs fees or other freight related charges).

3. Return address

Please send the part(s) or equipment to the address offered by Customer Service Department.

Service

Mindray maintains a network of service representatives and factory-trained distributors. Prior to requesting service, perform a complete operational check of the instrument to verify proper control settings. If operational problems continue to exist, contact Mindray service.

In North America contact the Service Department at (800) 288-2121, ext: 8116 for Technical Support or (201) 995-8000 for assistance in determining the nearest field service location.

Please include the instrument model number, the serial number, and a description of the problem with all requests for service.

Any questions regarding the warranty should be directed to your local sales or service representative.

NOTE

- **Upon request, Mindray provides circuit diagrams, component part lists, descriptions, calibration instructions, or other information which assist the user's appropriately qualified technical personnel to repair those parts of the equipment which are designated by Mindray DS USA, Inc. as repairable.**
-

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|----------------------|---|
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Preface

Manual Purpose

This manual provides detailed information about the assembly, disassembly, 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. Use of the manual is necessary for proper equipment maintenance and will help to eliminate equipment damage and personal injury.

This manual is based on the maximum configuration; therefore, some contents may not apply to your monitor. If you have any question, please contact our Customer Service Department.

Intended Audience

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

Contact your local Mindray Service Organization for information on product courses which address service and support for this product.

Passwords

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

- User maintenance: MIN888 (User adjustable)
- Configuration mode: MIN315 (User adjustable)

It is recommended that the user should change the passwords for user maintenance and configuration mode once they take ownership of the equipment.

FOR YOUR NOTES

Contents

| | |
|---|------------|
| 1 Safety | 1-1 |
| 1.1 Safety Information | 1-1 |
| 1.1.1 DANGER..... | 1-2 |
| 1.1.2 Warnings | 1-2 |
| 1.1.3 Cautions | 1-2 |
| 1.1.4 Notes | 1-2 |
| 1.2 Equipment Symbols..... | 1-2 |
| 2 Operation Theory | 2-1 |
| 2.1 Overview..... | 2-1 |
| 2.2 Product System Architecture..... | 2-1 |
| 2.2.1 Functions of the Main Control Module..... | 2-3 |
| 2.2.2 AC-DC Module | 2-4 |
| 2.2.3 Functions and Socket Definitions of the DCDC Board | 2-4 |
| 2.2.4 Front Housing Interface Board..... | 2-7 |
| 2.2.5 iView Substrate | 2-8 |
| 2.3 Power System..... | 2-8 |
| 2.3.1 Power Diagram of the Main Unit and the Module Rack | 2-8 |
| 2.3.2 The Secondary Screen of N22/N19 Uses Independent AC Adapter for Power Supply..... | 2-9 |
| 2.4 Signal Logic Flow | 2-9 |
| 2.4.1 Startup Signal Flow | 2-9 |
| 2.4.2 Display Signal Flow | 2-10 |
| 2.4.3 Display Brightness Control | 2-11 |
| 2.4.4 Module Initialization..... | 2-12 |
| 3 Testing and Maintenance..... | 3-1 |
| 3.1 Introduction..... | 3-1 |
| 3.1.1 Test Equipment..... | 3-1 |
| 3.1.2 Preventative Maintenance..... | 3-1 |
| 3.1.3 Recommended Frequency..... | 3-2 |
| 3.2 Preventative Maintenance Procedures | 3-3 |
| 3.2.1 Visual Inspection | 3-3 |
| 3.2.2 NIBP Tests..... | 3-4 |
| 3.2.3 Sidestream and Microstream CO ₂ Tests | 3-6 |
| 3.2.4 AG Tests | 3-8 |
| 3.3 Power On Test..... | 3-11 |
| 3.4 Module Performance Tests | 3-11 |
| 3.4.1 ECG Tests | 3-11 |
| 3.4.2 Resp Performance Test..... | 3-12 |
| 3.4.3 SpO ₂ Test | 3-12 |
| 3.4.4 NIBP Tests..... | 3-12 |
| 3.4.5 Temp Test | 3-13 |
| 3.4.6 IBP Tests | 3-13 |

| | |
|--|------------|
| 3.4.7 C.O. Test | 3-15 |
| 3.4.8 Sidestream and Microstream CO ₂ Tests | 3-15 |
| 3.4.9 AG Tests..... | 3-15 |
| 3.4.10 EEG Test..... | 3-15 |
| 3.4.11 BIS Test | 3-17 |
| 3.4.12 CCO/SvO ₂ Tests | 3-17 |
| 3.4.13 NMT Tests | 3-18 |
| 3.5 Nurse Call Relay Performance Test | 3-19 |
| 3.6 Analog Output Performance Test | 3-19 |
| 3.7 Electrical Safety Tests | 3-20 |
| 3.8 Recorder Check | 3-20 |
| 3.9 Network Print Test | 3-21 |
| 3.9.1 Device Connection and Setup | 3-21 |
| 3.10 Battery Check | 3-21 |
| 3.11 Mounting Check..... | 3-22 |
| 3.11.1 Safety check | 3-22 |
| 3.11.2 Overall Test and Check of Installed System | 3-22 |
| 4 Troubleshooting | 4-1 |
| 4.1 Introduction | 4-1 |
| 4.2 Part Replacement | 4-1 |
| 4.3 Check before Powering on the Monitor..... | 4-1 |
| 4.4 Software Version Check..... | 4-1 |
| 4.5 Technical Alarm Check..... | 4-2 |
| 4.6 Blank Screen upon Startup | 4-2 |
| 4.7 Troubleshooting Guide | 4-3 |
| 4.7.1 Power On/Off Failures | 4-3 |
| 4.7.2 Display Failures | 4-4 |
| 4.7.3 Module Rack Failures | 4-5 |
| 4.7.4 Alarm Failures | 4-6 |
| 4.7.5 Output Interface Failures | 4-7 |
| 4.7.6 Power Supply Failures | 4-7 |
| 4.7.7 Network Related Problems | 4-8 |
| 4.7.8 Device Integration Failures | 4-9 |
| 5 Hardware Configuration Options | 5-1 |
| 5.1 Overview | 5-1 |
| 5.2 Optional Parameter Function Modules | 5-2 |
| 5.3 Optional Functional Assemblies | 5-3 |
| 5.3.1 Installing an SMR | 5-3 |
| 5.3.2 Installing an Secondary Display | 5-3 |
| 5.3.3 Upgrading Split Unit | 5-4 |
| 5.3.4 Setting up Wireless Network Functions | 5-4 |
| 5.3.5 Upgrading Handle Assembly | 5-4 |
| 5.3.6 Installing the Main Unit Battery | 5-4 |

| | |
|---|------------|
| 5.3.7 Upgrading iView System Functions | 5-4 |
| 6 Disassembly and Repair | 6-1 |
| 6.1 Tools | 6-1 |
| 6.2 Preparations for Disassembly | 6-1 |
| 6.3 Whole Unit Disassembly | 6-1 |
| 6.3.1 Disassembling Display and Main Unit (Main Unit and Display Integrated Installation) | 6-2 |
| 6.3.2 Removing Handle/Encoder (Optional Encoder) | 6-3 |
| 6.3.3 Removing Handle Cover | 6-4 |
| 6.3.4 Removing Main Unit Housing/Main Unit Interface Adapter Board (Main Unit and Display Separated Installation) | 6-4 |
| 6.3.5 Removing Display Interface Adapter Board (Main Unit and Display Separated Installation) | 6-5 |
| 6.4 Disassembling Display (Capacitive Touchscreen) | 6-6 |
| 6.4.1 Removing Display Rear Housing Assembly (D19) | 6-6 |
| 6.4.2 Removing Display Rear Housing Assembly (D22) | 6-7 |
| 6.4.3 Removing Switch Keypad Board | 6-7 |
| 6.4.4 Removing Display Interface Board/Touchscreen Panel | 6-8 |
| 6.4.5 Removing USB Board | 6-9 |
| 6.4.6 Removing LED Board/Indicator Board | 6-10 |
| 6.5 Disassembling Main Unit | 6-10 |
| 6.5.1 Removing iView Assembly (iView Assembly Optional) | 6-10 |
| 6.5.2 Removing iView Assembly Support Board/USB Interface Board (iView Assembly Optional) | 6-11 |
| 6.5.3 Removing Battery | 6-11 |
| 6.5.4 Removing ACDC Power Board | 6-12 |
| 6.5.5 Removing DCDC Power Management Board | 6-13 |
| 6.5.6 Removing Antenna Module and Antenna Cable | 6-13 |
| 6.5.7 Removing SSD Hard Disk | 6-14 |
| 6.5.8 Removing Main Control Board | 6-14 |
| 6.5.9 Removing Battery Backplane | 6-15 |
| 6.6 Disassembling the Module Rack | 6-15 |
| 6.6.1 Disassembling the Handle and Hooks | 6-15 |
| 6.6.2 Disassembling the Rear Case of Module Rack | 6-16 |
| 6.6.3 Disassembling the Module Rack Interface Board | 6-16 |
| 6.6.4 Disassembling the Infrared Backplane of Module Rack | 6-17 |
| 6.7 Disassembling the M51C Module | 6-18 |
| 6.7.1 Disassembling the Front Panel Assembly | 6-18 |
| 6.7.2 Disassembling the Parameter Board | 6-18 |
| 6.7.3 Disassembling the SpO2 board | 6-19 |
| 6.7.4 Disassembling the Infrared Board | 6-19 |
| 6.7.5 Removing the Pump and Valve | 6-19 |
| 7 Parts | 7-1 |
| 7.1 Main Unit | 7-1 |
| 7.1.1 Exploded View | 7-1 |
| 7.1.2 Parts List | 7-1 |
| 7.2 D19 Display Assembly (Capacitive Screen) | 7-3 |

| | |
|--|------------|
| 7.2.1 Exploded View..... | 7-3 |
| 7.2.2 Parts List..... | 7-3 |
| 7.3 D22 Display Assembly (Capacitive Screen) | 7-5 |
| 7.3.1 Exploded View..... | 7-5 |
| 7.3.2 Parts List..... | 7-5 |
| 7.4 Encoder Assembly..... | 7-7 |
| 7.4.1 Exploded View..... | 7-7 |
| 7.4.2 Parts List..... | 7-7 |
| 7.5 Module Rack..... | 7-8 |
| 7.5.1 Exploded View..... | 7-8 |
| 7.5.2 Parts List..... | 7-8 |
| 7.6 iVIEW Module..... | 7-9 |
| 7.6.1 Exploded View..... | 7-9 |
| 7.6.2 Parts List..... | 7-9 |
| 7.7 Main Unit Separated Installation Auxiliary Accessories | 7-10 |
| 7.7.1 Exploded View..... | 7-10 |
| 7.7.2 Parts List..... | 7-10 |
| 7.8 Main Unit Base Assembly | 7-11 |
| 7.8.1 Exploded View..... | 7-11 |
| 7.8.2 Parts List..... | 7-11 |
| 7.9 Battery Cavity Assembly | 7-13 |
| 7.9.1 Exploded View..... | 7-13 |
| 7.9.2 Parts List..... | 7-13 |
| 7.10 M51C Module..... | 7-14 |
| 7.10.1 Exploded View | 7-14 |
| 7.10.2 Parts List | 7-14 |
| A Electrical Safety Inspection..... | A-1 |
| A.1 Power Cord Plug..... | A-1 |
| A.2 Device Enclosure and Accessories | A-1 |
| A.3 Device Labelling | A-2 |
| A.4 Scheduled Electrical Safety Inspection | A-2 |
| A.5 Electrical Safety Inspection after Repair | A-2 |
| A.6 Electrical Safety Inspection Test..... | A-3 |

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.
-

1.1.1 DANGER

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 should be 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, verify 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 (P/N: 046-011259-00) for information about the symbols used on this product and its packaging.

2 Operation Theory

2.1 Overview

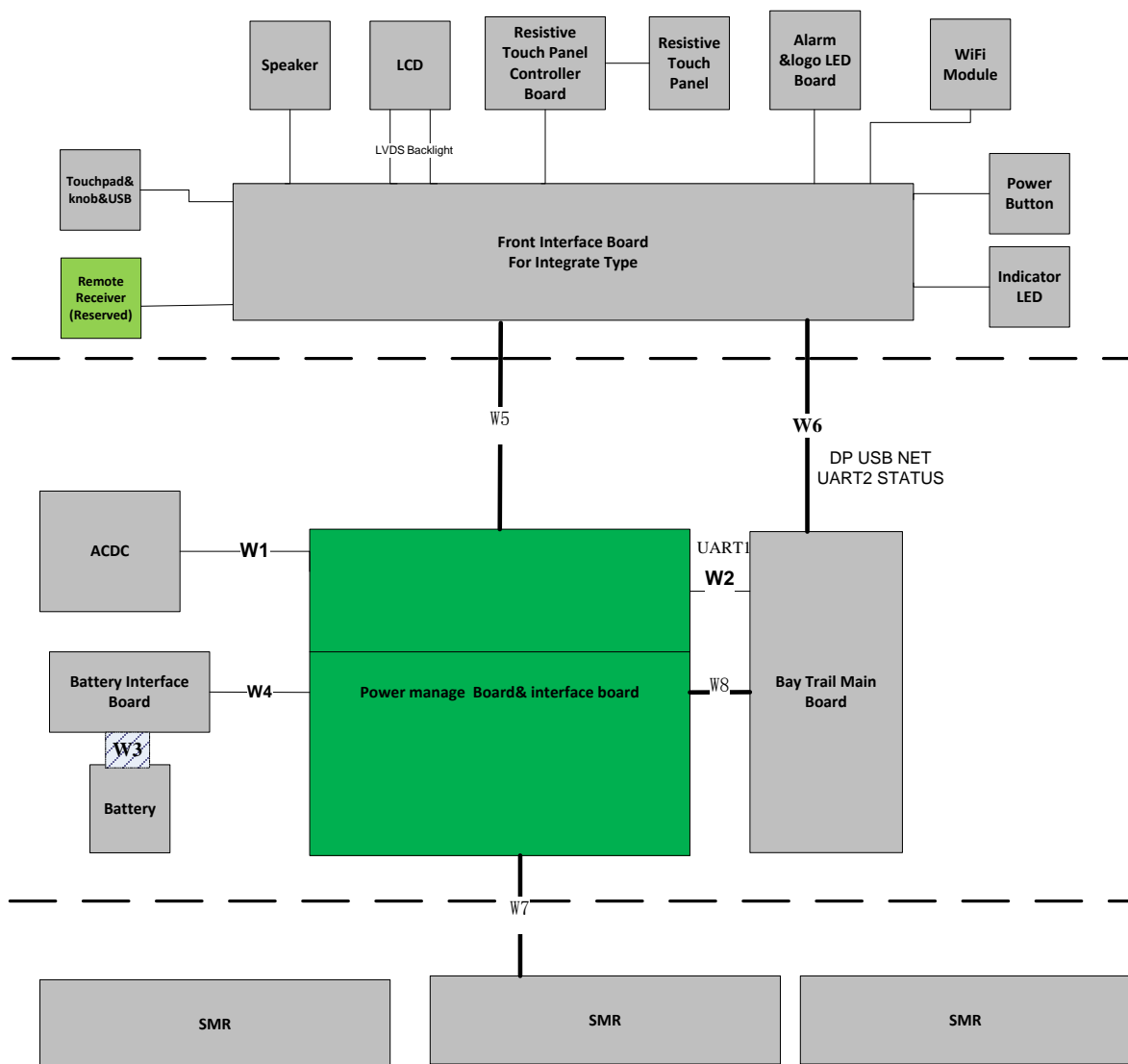
TheN22/N19 patient monitor provides rich functionality to monitor patient's vital signs including ECG, Resp, SpO₂, Temp, NIBP, IBP, CO₂, AG, O₂, RM, C.O., CCO, ICG, SvO₂/ScvO₂, BIS, EEG, NMT, tcGas and rSO₂. Based on these parameters, the monitor supports alarm management, data review, recording and 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:

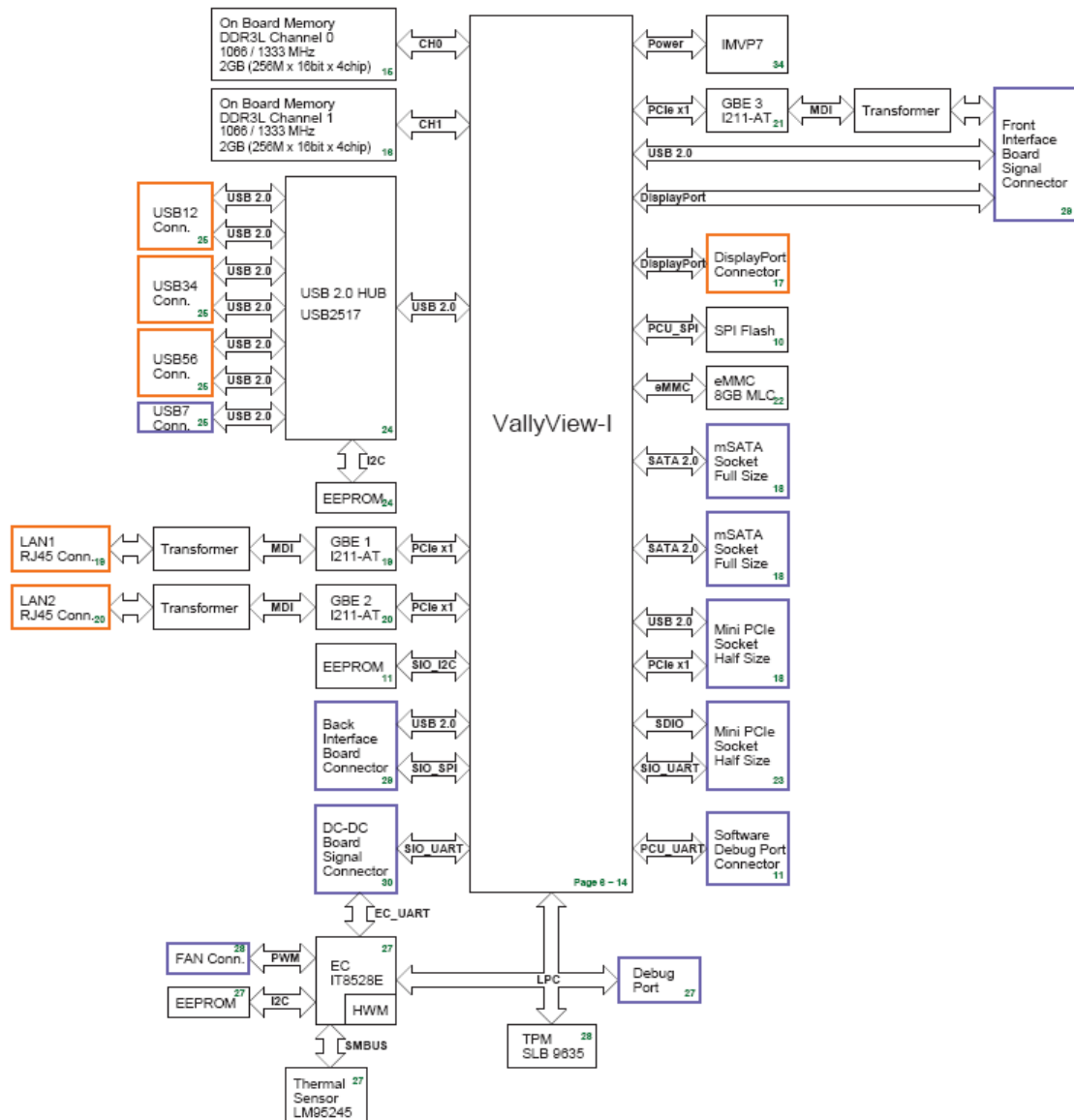
Main unit: DCDC and interface board, ACDC board, and main board and interface board.

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

The DCDC board is responsible for the conversion of the data signal of the main board into the external interface and is responsible for generating the various DC voltages the hardware system requires 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 | / |
| 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 | / |

| Connector Type | 5015714007 | | | |
|----------------|-------------|------------------|----------------------|---------|
| Pin No. | Signal Name | Signal Direction | Function Definition | Remarks |
| | | | 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 | / |

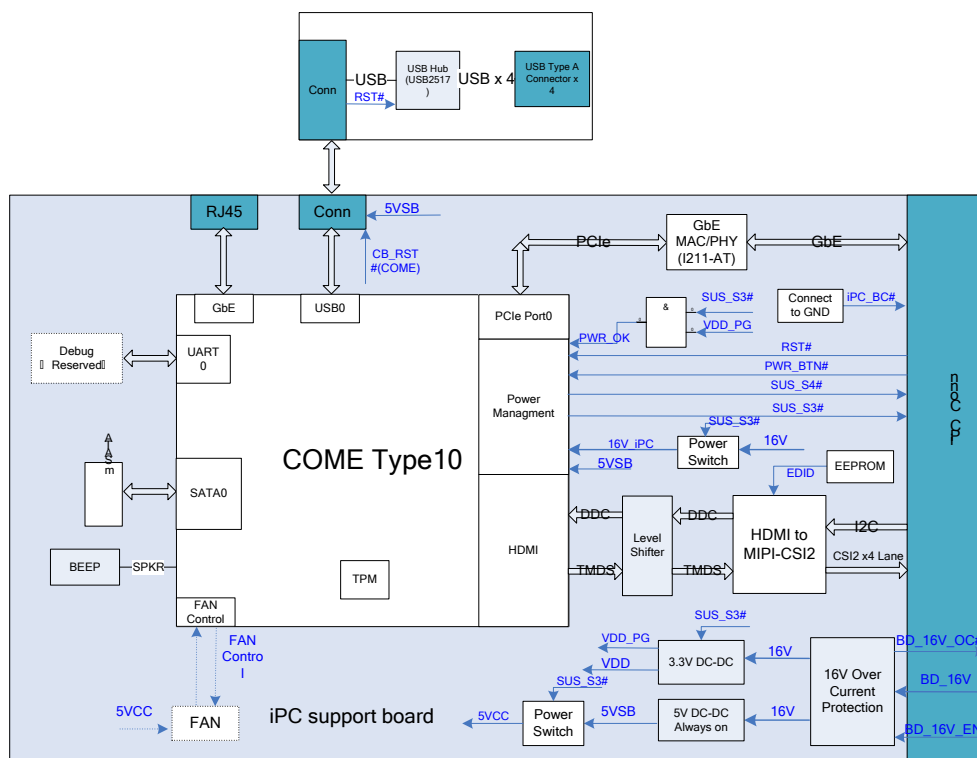
2.2.4 Front Housing Interface Board

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 interface board has much to control, a microcontroller unit (MCU) is used for the central control. The MCU is connected to the main control of the system through the DisplayPort AUX channel (DP AUX), and the USB connection channel is reserved.

2.2.5 iView Substrate

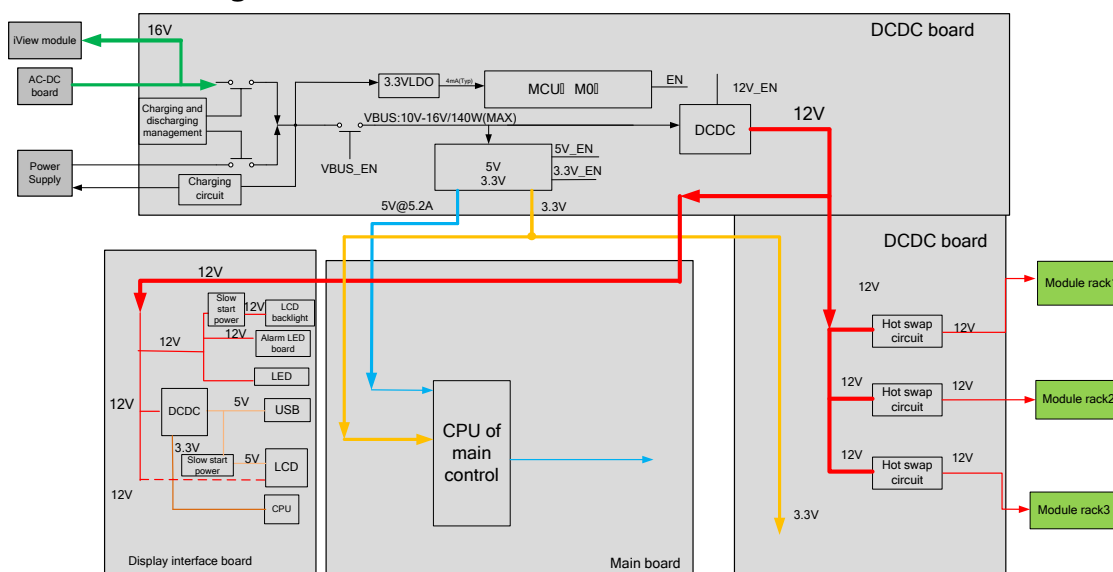
iView substrate is mainly used to carry the COME module (COM Express module), extending the function of the COME to standard interfaces as well as communication signals with the main board.



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

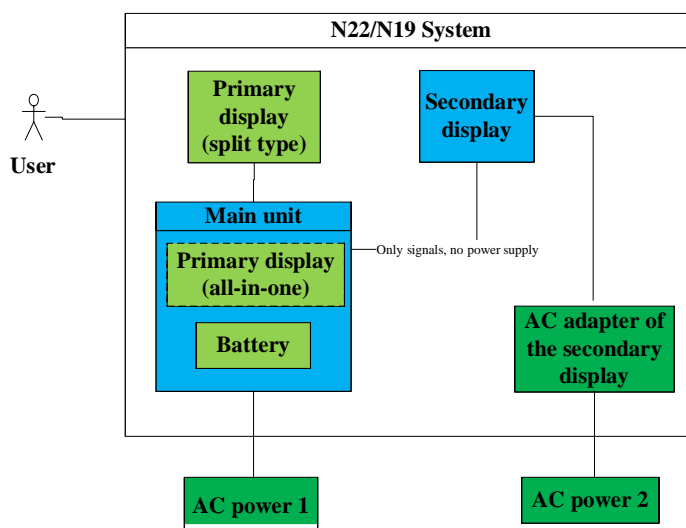
2.3.1 Power Diagram of the Main Unit and the Module Rack



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 primary and secondary display controls are independent of each other, allowing the secondary display to be turned on or off without affecting the complete system.

2.4 Signal Logic Flow

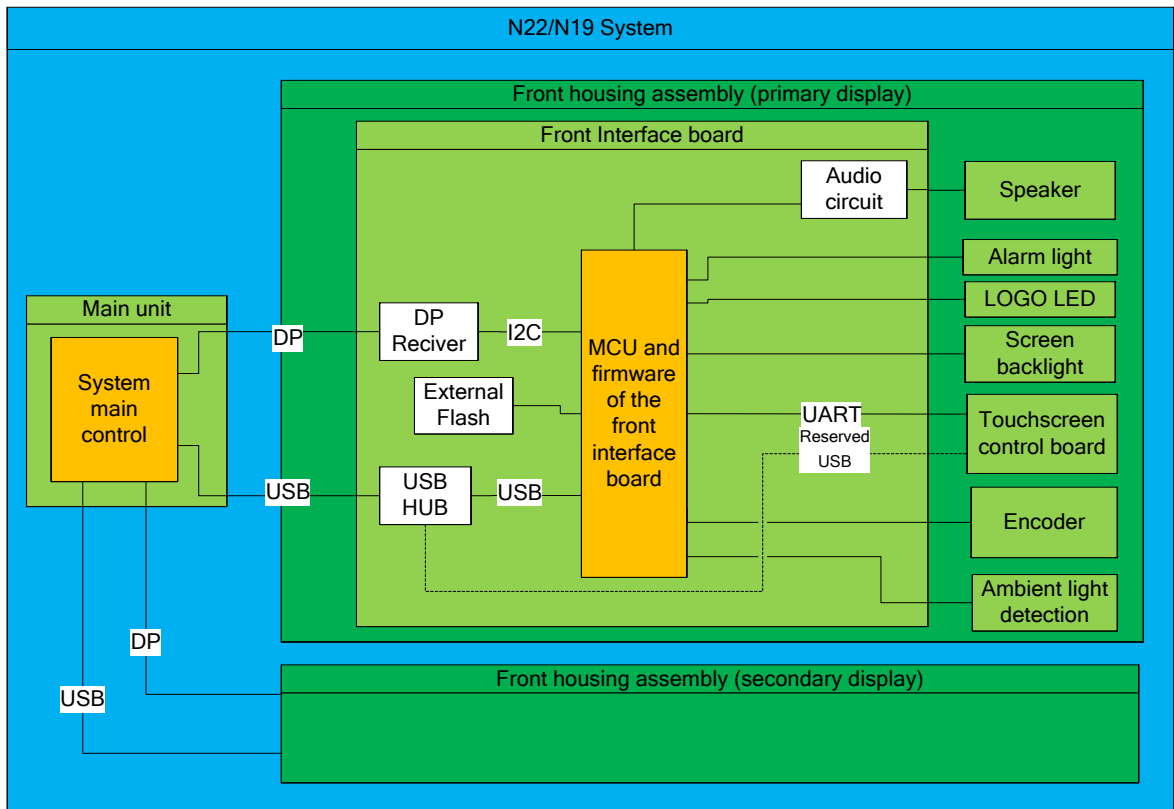
2.4.1 Startup Signal Flow

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: If the display is connected to the AC power supply, power failure of the main unit will not cause display power failure.. Therefore, to completely disconnect the power supply from the system, disconnect the AC power cord of the main unit, and hold the power switch for 15 seconds. Disconnect the AC power cord of the display..

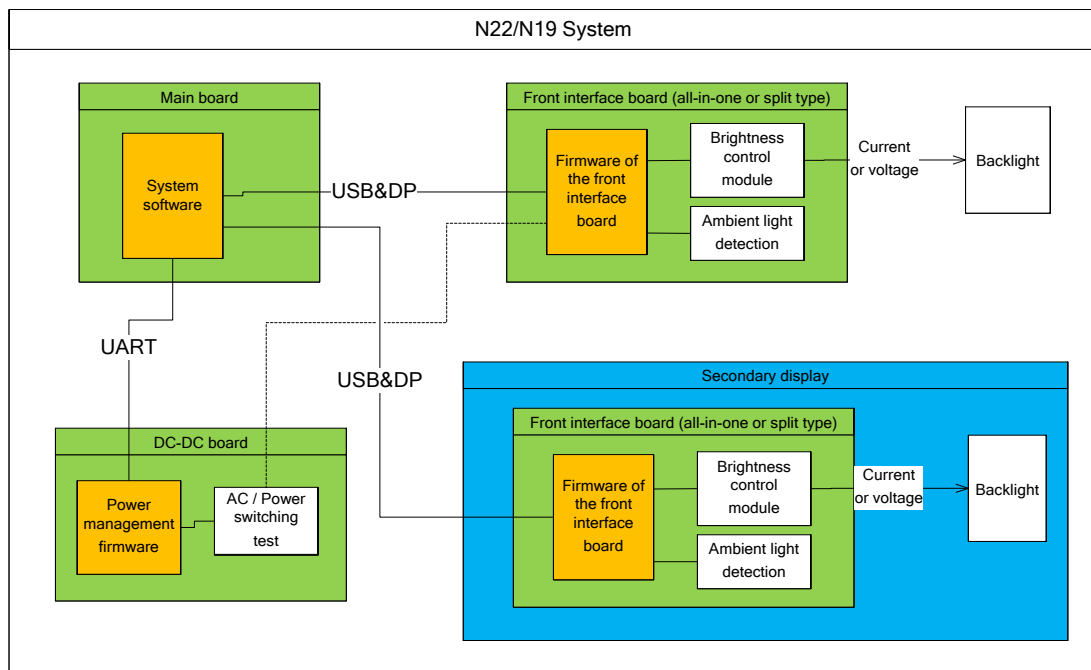
2.4.2 Display Signal Flow



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.

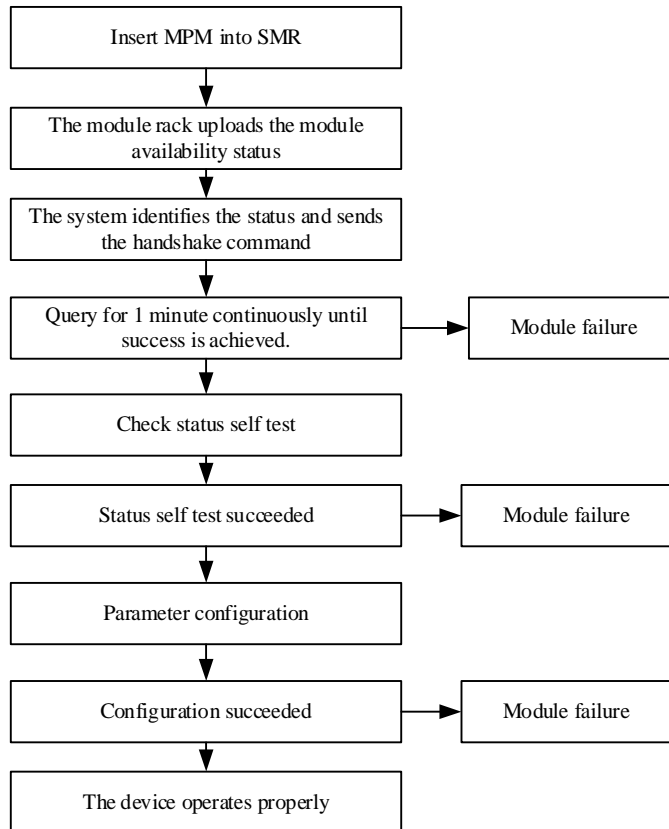
During operation, the system software adjusts the display brightness of the primary screen or secondary screen by directly sending command to the primary screen or secondary screen, and the CPU within the primary screen or secondary screen adjusts the backlight accordingly.

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, N1, or T1 as an example:



3 Testing and Maintenance

3.1 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.



- **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.**
-

3.1.1 Test Equipment

Required Test Equipment is listed in the specific test procedure.

3.1.2 Preventative Maintenance

The following sections provide a list of recommended preventative maintenance procedures. It is recommended to verify accuracy and calibrate the patient monitor as needed at least once every two years (and once a year for CO₂ and AG modules). See the following sections for detailed test procedures and contents.

3.1.3 Recommended Frequency

| Check/Maintenance Item | | Frequency |
|--|--------------------------|--|
| Preventative Maintenance Tests | | |
| Visual inspection | | When first installed or reinstalled. |
| NIBP tests | Pressure check | <div>1. If the user suspects that the measurement is incorrect.</div> <div>2. Following any repair or replacement of relevant module.</div> <div>3. For NIBP module, at least once every two years; for CO₂ and AG modules, once a year.</div> <div>4. AG leakage test should be performed before AG measurement.</div> |
| | Leakage test | |
| Sidestream and Microstream CO ₂ tests | Leakage test | |
| | Performance test | |
| | Calibration | |
| AG tests | Performance test | |
| | Calibration | |
| Performance Tests | | |
| ECG tests | Performance test | <div>1. If the user suspects that the measurement is incorrect.</div> <div>2. Following any repair or replacement of relevant module.</div> <div>3. At least once every two years. For CO₂, AG and NMT modules, at least once a year.</div> <div>4. AG leakage test should be performed before AG measurement.</div> |
| | Calibration | |
| Resp test | | |
| SpO ₂ test | | |
| NIBP test | Pressure check | |
| | Leakage test | |
| Temp test | | |
| IBP tests | Performance test | |
| | Pressure calibration | |
| C.O. test | | |
| Sidestream and Microstream CO ₂ tests | Leakage test | |
| | Performance test | |
| | Calibration | |
| AG tests | Leakage test | |
| | Performance test | |
| | Calibration | |
| EEG test | | |
| BIS test | | |
| CCO/SvO ₂ tests | Interconnecting function | |
| | Output calibration | |
| NMT tests | Performance test | |
| | Sensor check | |
| Nurse call relay performance test | | If the user suspects that the nurse call or analog output does not function properly. |
| Analog output performance 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. |
| 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 every two months 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 rSO₂, and ScvO₂ modules, because the rSO₂ modules perform self tests, and the ScvO₂ needs to be calibrated prior to use.

3.2 Preventative Maintenance Procedures

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

3.2.2 NIBP Tests

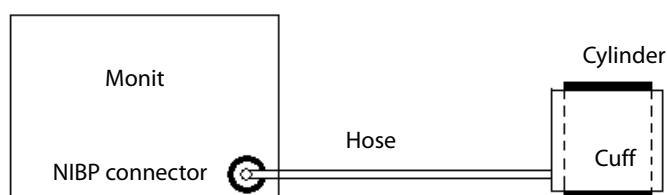
3.2.2.1 Leakage Test

Tools required:

- NIBP cuff for adult patient
- NIBP hose
- 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 Airway 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 **1.2.2.2 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.

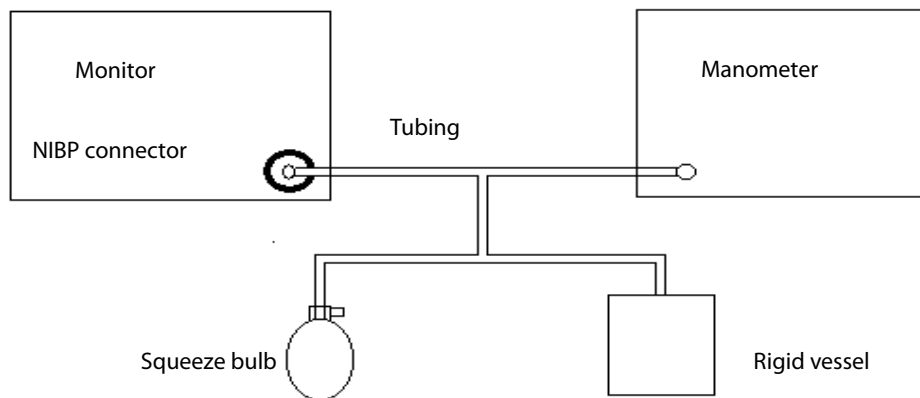
3.2.2.2 NIBP Accuracy Test

Tools required:

- T-shape connector
- Tubing
- Squeeze bulb
- Rigid vessel with 500 ± 25 ml internal volume
- 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 or less. 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.

3.2.3 Sidestream and Microstream CO₂ Tests

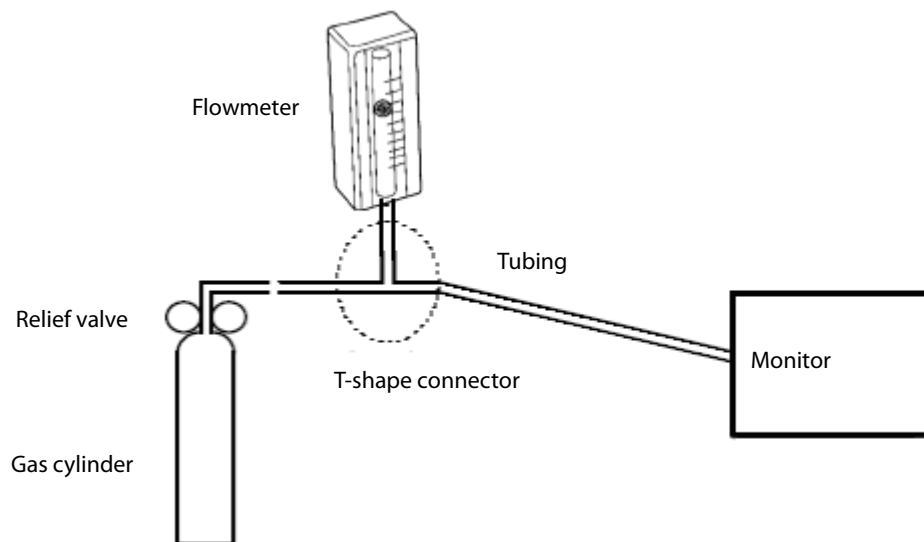
Leakage Test

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

Accuracy Test

Tools required:

- For microstream CO₂ module and sidestream CO₂ module without O₂ module, a gas cylinder with 5±0.03% CO₂, 21.0% O₂ and balance gas N₂ (P/N 0075-00-0033-01) or a steel gas cylinder with:
 - ◆ CO₂ concentration 3% - 7% ☐
 - ◆ $a/c \leq 0.01$ (where a = absolute gas concentration accuracy, c = gas concentration) ☐
 - ◆ balance gas N₂
 - For sidestream CO₂ module with O₂ module equipped, a steel gas cylinder (P/N 0075-00-0048-01) with 6% CO₂, 4% Desflurane, 45% N₂O, and 45% O₂,
 - T-shape connector
 - Tubing
 - Flowmeter
1. Plug the module into the module rack.
 2. Wait until the CO₂ module warmup is finished. Check the airway for leak and perform a leakage test as well to make sure that the airway has no leak.
 3. Select Main Menu → Maintenance → enter the required password → Module → CO₂.
 4. Connect the test system as follows:



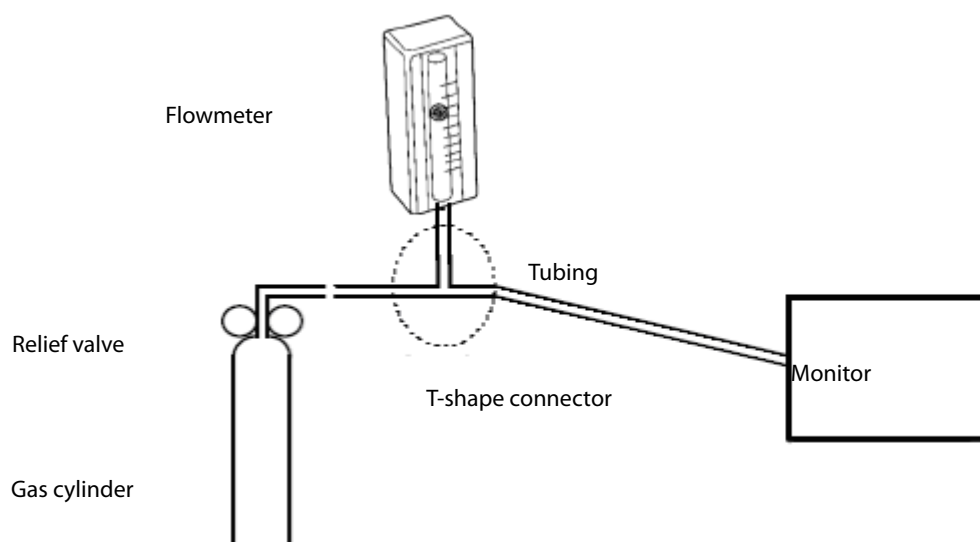
5. Open the relief valve, and adjust it until the flowmeter has a stable reading between 10 ml/min and 50 ml/min.
6. Verify that the real-time CO₂ value is within $6 \pm 0.2\%$ in the CO₂ Maintenance menu (for microstream CO₂, the value is 45 ± 2 mmHg).
7. Replace the cylinder to the steel gas cylinder with $>40\%$ O₂ and balance gas N₂ (applicable to sidestream CO₂ module with O₂ module equipped) and verify that the real-time O₂ value error is within $\pm 2\%$ (when $O_2 \leq 80\%$) or $\pm 3\%$ ($80\% \leq O_2 \leq 100\%$).

Calibration

Tools required:

- For microstream CO₂ module and sidestream CO₂ module without O₂ module, a gas cylinder with $5 \pm 0.03\%$ CO₂, 21.0% O₂ and balance gas N₂ (P/N 0075-00-0033-01) or a steel gas cylinder with: ☐
 - ◆ CO₂ concentration 3% - 7% ☐
 - ◆ $a/c \leq 0.01$ (where a = absolute gas concentration accuracy, c = gas concentration) ☐
 - ◆ balance gas N₂
- For sidestream CO₂ module with O₂ module equipped, a steel gas cylinder (P/N 0075-00-0048-01) with 6% CO₂, 4% Desflurane, 45% N₂O, and 45% O₂,
- T-shape connector
- Tubing
- Flowmeter

1. Make sure that the sidestream or microstream CO₂ 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 Maintenance 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, select 6% (the CO₂ concentration) for CO₂ calibration. The measured CO₂ concentration is displayed.
8. After the measured CO₂ concentration becomes stable, select Calibrate CO₂ to calibrate the CO₂ module.
9. Replace the cylinder to the steel gas cylinder with >40% O₂ and balance gas N₂ (applicable to sidestream CO₂ module with O₂ module equipped) and calibrate O₂.

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

3.2.4 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

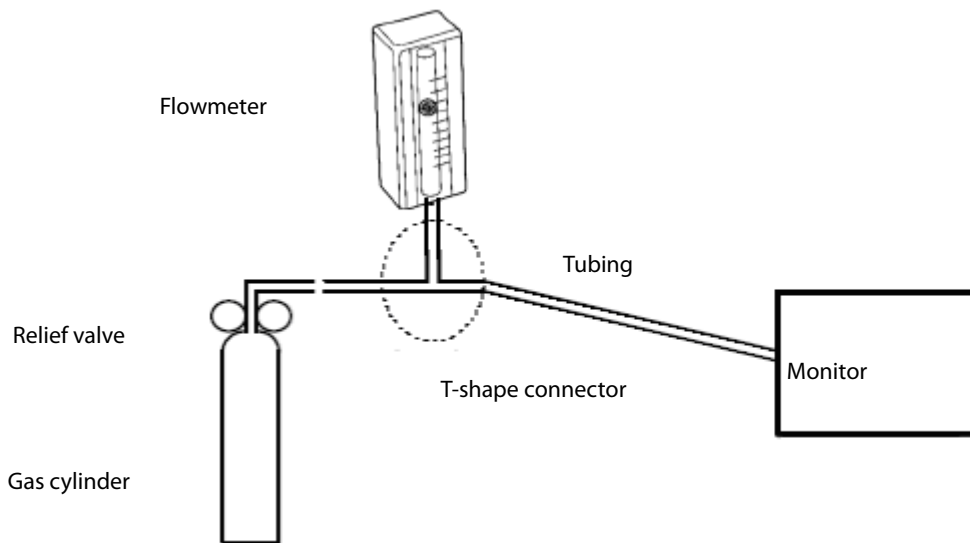
Tools required:

- Gas cylinder with a certain standard gas (such as 6±0.05% CO₂, Bal N₂) or standard gas mixture. Gas concentration should meet the following requirements: AA > 1.5%, CO₂ > 1.5%, N₂O > 40%, O₂ > 40%, 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

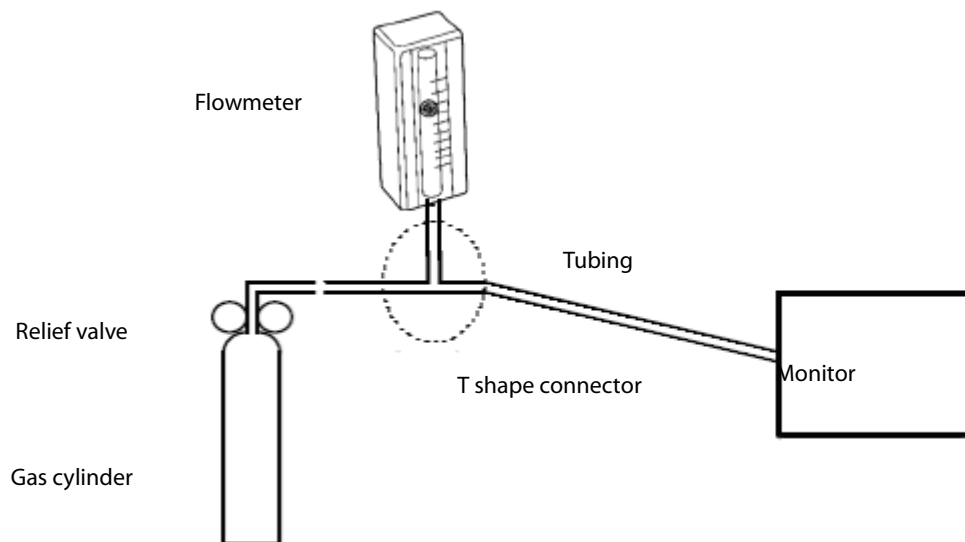
Tools required:

- A supply of medical grade 100% O₂ and an anesthetic calibration gas (4% Desflurane, 6% CO₂, 45% N₂O, Bal O₂, P/N: 0075-00-0048-01 and flow regulator P/N: 0119-00-0235). Gas concentration should meet the following requirements:
 - ◆ $AA \geq 1.5\%$, $CO_2 \geq 1.5\%$, $N_2O \geq 40\%$, $O_2 \geq 40\%$, of which AA represents an anesthetic agent.
 - ◆ $a/c \leq 0.01$ (a is the gas absolute concentration accuracy; c is the gas concentration)
- T-shape connector
- Tubing

Follow this procedure to perform a calibration:

1. Select Main Menu → Maintenance → enter the required password → Module → AG.
2. Check the airway and make sure that there are no occlusions or leaks.

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



5. In the Calibrate AG menu, the concentration and flowrate of each measured gas are displayed.
 - ◆ If the difference between the measured gas concentration and the actual one is within tolerance, a calibration is not needed.
 - ◆ If the difference is not within tolerance, a calibration should be performed. Select Calibrate.
6. Enter the vented gas concentration. If you use only one gas for calibration, set other gases' concentration to 0. If the calibration is performed for all gases, the gas with an entered calibration value of 0 is not calibrated.
7. Select Calibrate to start a calibration.
8. If the calibration is finished successfully, the message Calibration Completed! is displayed. If the calibration failed, the message Calibration Failed! is displayed. In this case, perform another calibration. If the calibration fails several times, return the module to Mindray for repair.

CAUTION

- **Calibrate the O₂ module, if it has been transported for long distance.**

3.3 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 sound is passed.
3. The patient monitor enters the main screen and start-up is finished.

3.4 Module Performance Tests

3.4.1 ECG Tests

ECG Performance Test

Tools required:

- Medsim300B patient simulator or other equivalent 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 **Calibration**. A square wave appears on the screen and the message "**ECG Calibrating**" is displayed.
4. Compare the amplitude of the square wave with that of the scale. The difference should be with 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.

3.4.2 Resp Test

Tools required:

- Medsim300B patient simulator or other equivalent 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.

3.4.3 SpO₂ Test

Tools required:

- None.

1. Connect SpO₂ sensor to the SpO₂ connector of the monitor. Set Patient Category to Adult and PR Source to SpO₂ on the monitor.
2. Apply the SpO₂ 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 SpO₂ is within 95% and 100%.
4. Remove the SpO₂ sensor from your finger and make sure that an alarm of SpO₂ Sensor Off is triggered.

Measurement accuracy verification:

The SpO₂ 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 SpO₂ sensor. Instead, it can only verify that whether the monitor is functional. The accuracy of a pulse oximeter monitor or a SpO₂ sensor needs to be verified by clinical data.**
-

3.4.4 NIBP Tests

See section **3.2.2 NIBP Tests**.

3.4.5 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 $37 \pm 0.1^\circ\text{C}$.
 4. Repeat steps 1 to 3 to verify each Temp channel of the monitor.

3.4.6 IBP Tests

Performance Test

Tools required:

- Patient simulator Medsim300B, MPS450, or other equivalent equipment
 - Dedicated IBP adapter cable (P/N 00-002199-00 for 300B, P/N 00-002198-00 for 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 error is beyond ± 2 mmHg, 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.
 8. Repeat the preceding steps to test all IBP channels.

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 from the IBP menu.
 4. Set static pressure to 200 mmHg on the patient simulator.
 5. Select **Main Menu** → **Maintenance** → enter the required password → **Module** → **IBP**.
 6. Set the calibration value to 200 mmHg.

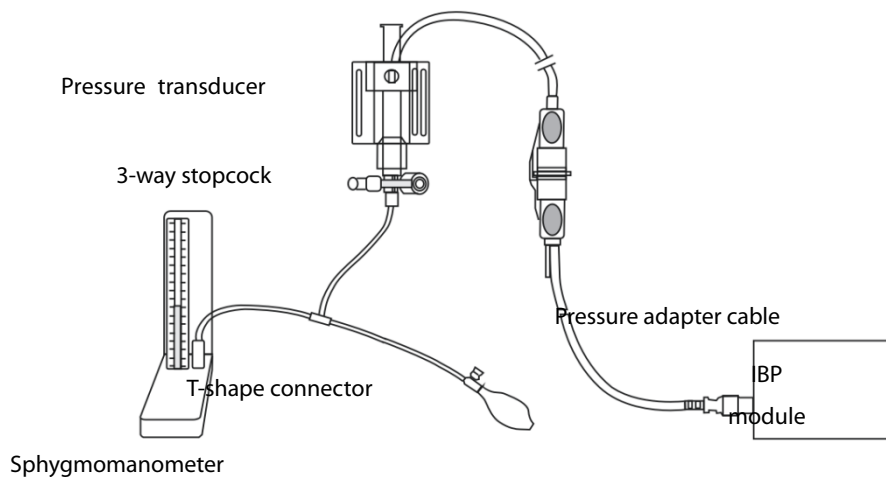
7. Select the Calibrate button next to the desired IBP channel to start a calibration.
8. If the calibration is completed successfully, the message Calibration Completed! will be displayed. Otherwise, a corresponding message will be displayed.

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 IBP Maintenance 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.

3.4.7 C.O. Test

Tools required:

- Medsim300B patient simulator or other equivalent 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 37°C on the patient simulator and check the temperature value is $37 \pm 0.1^\circ\text{C}$.
3. Switch off Auto TI and adjust TI (IT) to 24°C. Select C.O. Measure to enter the C.O. measurement window and set Comp. Const. to 0.595.
4. Set the injectate temperature to 24°C 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.
6. Verify that the C.O. value is 5 ± 0.25 L/min.

3.4.8 Sidestream and Microstream CO₂ Tests

See section **3.2.3 Sidestream and Microstream CO₂ Tests**.

3.4.9 AG Tests

See section **3.2.4 AG Tests**.

3.4.10 EEG Test

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

Method 1:

Tools required:

- ECG simulator with Sine wave output function.

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

Set the ECG simulator to output Sine wave and frequency to between 0.5 and 30Hz. The range is 2mV. The GND pin of EEG module connects to RL of ECG simulator. The A+ pin of EEG module connects to LA of ECG simulator. The other pins of EEG lead wires connect to any ECG lead as you wish.

2. Open the EEG setting menu on monitor, Set the Scale of EEG to be 2000uV. Then you can find a Sine wave on screen of Patient Monitor.

Method 2:

Tools required:

- None.

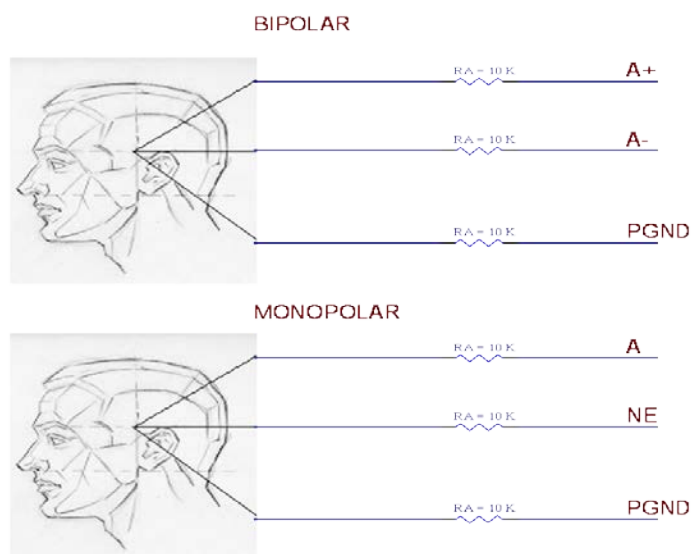
Connect all the pins of EEG lead wire together, for example, you can connect them to some metal materials. Then check the EEG module resistance test, if all the leads are green then pass.

Method 3:

Tools required:

- Resistance box
- Multimeter

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



3.4.11 BIS Test

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

Method 1:

Tools required:

- None.

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

Method 2:

Tools required:

- BIS simulator (Covidien PN: 186-0137)

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

Method 3:

Tools:

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

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

3.4.12 CCO/SvO₂ 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 SvO₂ tests in Demo mode.
3. Verify that the CCO/SvO₂ 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/SvO₂ 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 SpO₂ are 5 ± 0.015 V, 5 ± 0.25 V, 5 ± 0.25 V and 10 ± 0.5 V respectively.

3.4.13 NMT Tests

Performance Test

Method 1:

Tools required:

- Resistance box
- Multimeter

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

Method 2:

Tools required:

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

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

Sensor Check

Tools required: None.

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

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

NOTE

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

3.5 Nurse Call Relay Performance Test

Tools required: Multimeter

1. Connect the nurse call cable to the Nurse Call Connector of the patient monitor.
2. Enter Demo mode. Then, select Main Menu → Maintenance >> → enter the required password → Alarm to access the Nurse Call setup menu.
3. In Nurse Call menu, select all options of Alarm Priority and Alarm Type. and set Contact Type to Normally Open.
4. In Nurse Call menu, set Signal Type to Pulse. Cause the monitor to generate an alarm and verify the output are pulses of 1s width and the relay contacts are closed (can be measured with a multimeter) when there is an alarm.
5. In Nurse Call menu, set Signal Type to Continuous. Cause the monitor to generate an alarm and verify the output is continuous high level and the relay contacts are closed (can be measured with a multimeter) when there is an alarm.

3.6 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.

3.7 Electrical Safety Tests

WARNING

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

NOTE

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

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

3.8 Recorder Check

Tools required:

- None.

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

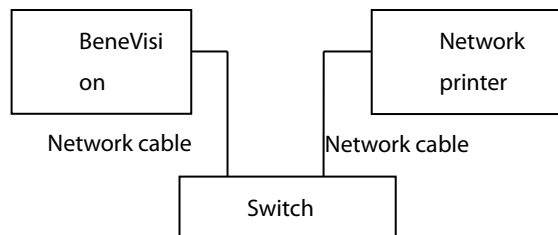
3.9 Network Print Test

NOTE

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

3.9.1 Device Connection and Setup

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



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

3.10 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.

3.11 Mounting Check

Tools required: None.

3.11.1 Safety check

Check the mounting of Patient Monitor is safe.

3.11.2 Overall Test and Check of Installed System

Implement installation test:

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

- 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 Troubleshooting

4.1 Introduction

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

4.2 Part Replacement

For the monitor, the PCB, main parts and components can be replaced. For the LCD or touch screen fault, only the front case assembly can be replaced. Once the faulty PCB is confirmed, replace the PCB according to the operation guide in **Chapter 6 Disassembly and Repair**. Then, confirm that the monitor can operate normally and has passed all the performance tests. For the information about replaceable parts, refer to **Chapter 7 Parts**.

4.3 Check before Powering on the Monitor

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

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

4.4 Software Version Check

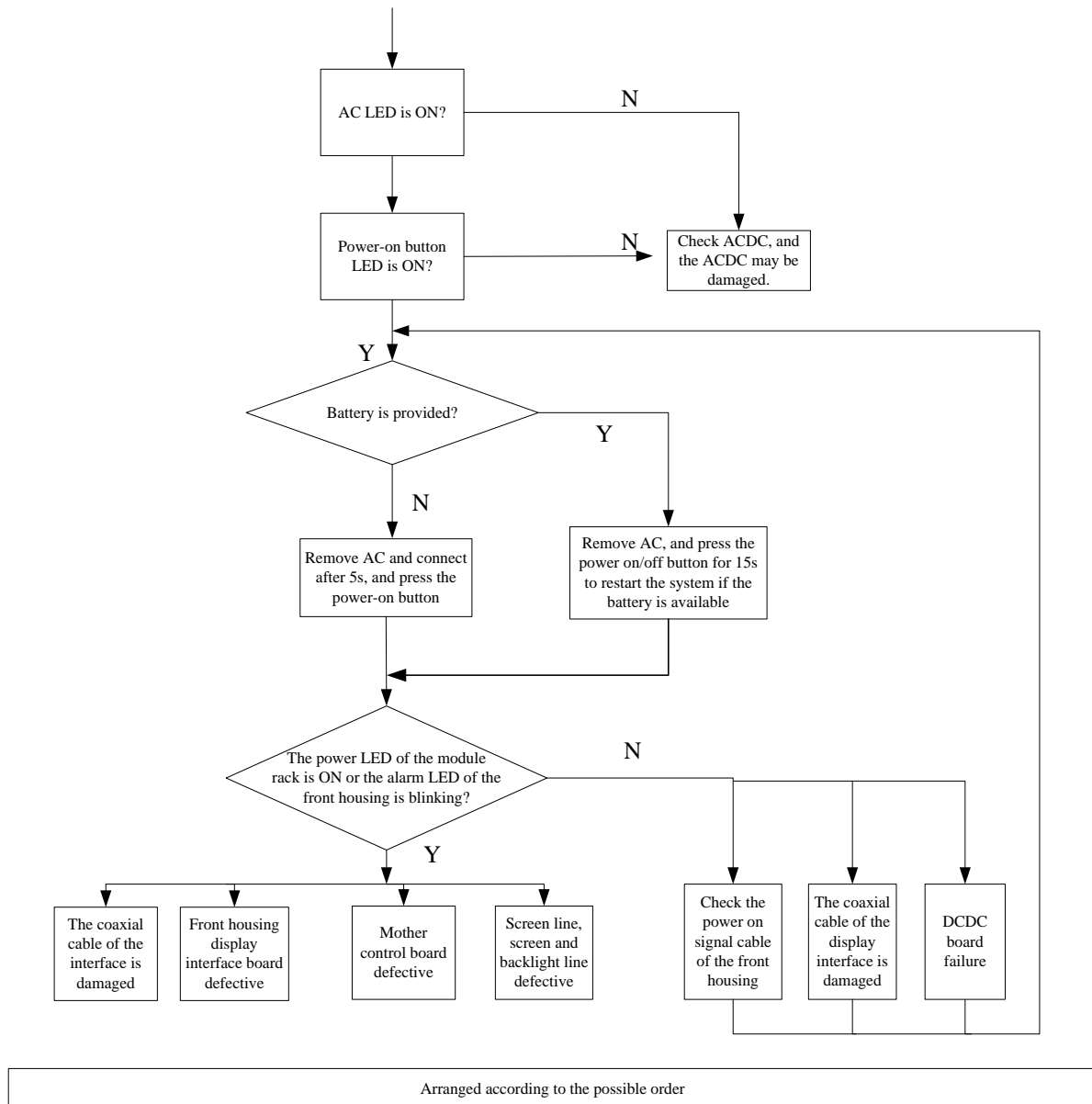
Some troubleshooting tasks may involve software version compatibility. For information about the configuration and software version of your patient monitor, contact Mindray service. To check the software version, do as follows:

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

4.5 Technical Alarm Check

Before troubleshooting the patient monitor, check for technical alarm message. If an alarm message is presented, eliminate the technical alarm first. For detailed information on technical alarm messages, possible causes and countermeasures, refer to N series Operator's Manual (P/N: 046-011259-00).

4.6 Blank Screen upon Startup




4.7 Troubleshooting Guide

4.7.1 Power On/Off Failures

| Fault Symptom | Possible Cause | Countermeasure |
|------------------|---|--|
| Power on failure | AC mains not connected or insufficient battery power or battery damaged | <ul style="list-style-type: none">■ Verify the AC mains is properly connected.■ Verify the battery capacity is sufficient and the battery is not damaged. |
| | Cable defective or improperly connected | <p>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.</p> <p>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.</p> <p>2. Verify the cables and connectors are not damaged.</p> |
| | Power switch & LED board defective | Replace the power switch & LED board. |
| | Power module defective | Replace the power module. |
| | Motherboard failure | Replace the motherboard. |

4.7.2 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 not inserted into the connector of the main unit when the system is powered on | Power off the main unit. Connect the DP cable of the secondary screen to the main unit. Then 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. |

4.7.3 Module Rack Failures

| Failure Description | Possible Cause | Troubleshooting |
|---------------------------------------|--|--|
| SMR cannot identify parameter modules | External cable defective or poorly connected | <ul style="list-style-type: none"> ■ The cable connecting SMR and the main unit of the monitor is not connected properly or already damaged. Verify the connecting cables and connectors are not damaged. ■ Verify that contact screws on SMR or module are tightly fastened and well connected. |
| | Defective parameter module | Replace the malfunctioning parameter module with a known good module. If the patient monitor identifies the replacement module and can start measurement, it indicates that the original module is faulty. |
| | Wrong communication board software version | Upgrade the module and/or the SMR software to a compatible level. |
| | SMR power supply abnormal | <ul style="list-style-type: none"> ■ Check whether the SMR interface output voltage of the main unit is 12 V. If it is abnormal, the internal module rack COM board or main control board fails. ■ Check whether the contact screw output voltage of the external module rack is 12 V. If it is abnormal, the communication module on the SMR fails. |
| | 8-slot Module rack communication board defective | Replace 8-slot the module rack communication board. |
| | DCDC board failure | Replace the DCDC board. |

4.7.4 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 the Main Menu quick key, from the System column, select Maintenance → enter required password → select Alarm , set Minimum Alarm Volume to a proper value. Select the Main Menu quick key, from the Alarm column, select Setup , 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. |

4.7.5 Output Interface Failures

| Fault Symptom | Possible Cause | Countermeasure |
|------------------------------|---|--|
| No output for the nurse call | 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. |
| USB Device Unusable | 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. |

4.7.6 Power Supply Failures

| Fault Symptom | Possible Cause | Countermeasure |
|-----------------------------|--|--|
| Battery cannot supply power | 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. |
| No +3.3 V output | 1. Power supply protected 2. DCDC interface board damaged | 1. Turn off the patient monitor then restart it. |
| No +5.0 V output | | 2. If the problem persists, disconnect the AC mains for 5s and reconnect it, and then restart the patient monitor. |
| No +12 V output | | 3. If the problem persists, replace the DCDC interface board. |

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.

4.7.7 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. |
| | Incorrect network settings | Verify the wireless network settings are correct. |
| | Antenna not installed properly | Verify the antenna for the wireless network card is connected to the wireless module reliably. |
| | Wireless module damaged | Replace the wireless module. |
| | Main control board failure | Replace the main control board. |
| | Antenna not installed properly | Verify the antenna for the MPAN module is installed properly. |
| | MPAN module damaged | Replace the MPAN module. |
| | Satellite module rack (SMR) COM board defective | Replace the SMR COM board. |
| | Wrong software version for the MPAN module | Upgrade the MPAN module software. |

4.7.8 Device Integration Failures

| Failure Description | Possible Cause | Troubleshooting |
|---|---|--|
| The "Devices Integrated" window displays nothing after connection | The ID adapter is not compatible with the external device | <ul style="list-style-type: none"> ■ Replace the ID adapter. ■ Upgrade the ID of the ID adapter in "Factory Maintenance" menu. |
| | The serial port adapter cable not compatible with the external device | Replace the serial port adapter cable. |
| | Wrong software version or wrong protocol version of the external device | Verify the protocol version and software version are supported by the ID adapter. |
| Generate the alarm: "BeneLink Comm Stop" | The BeneLink module application software is corrupted | Upgrade or update the software application of the BeneLink module with the network upgrading tool. |
| The patient monitor has no response when loading the ID adapter | The BeneLink module application software is corrupted | Upgrade or update the software application of the BeneLink module with the network upgrading tool. |
| | BeneLink module damaged | Replace the module. |

FOR YOUR NOTES

5 Hardware Configuration Options

5.1 Overview

This monitor supports optional monitoring parameter function modules, optional 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 Optional Parameter Function Modules

You can install the following parameter modules:

| Parameter Module | Part No. | Description |
|-----------------------------|---------------|--|
| MPM module | 115-056534-00 | MPM-2 module (Masimo SpO2/3/5 lead ECG/IBP, FRU) |
| | 115-056535-00 | MPM-3 module (Nellcor SpO2/3/5 lead ECG/IBP, FRU) |
| | 115-056536-00 | MPM-8 module (Nellcor SpO2/3/5 lead, FRU) |
| | 115-056537-00 | MPM-9 module (Nellcor SpO2/3/5 lead, FRU) |
| | 115-056538-00 | MPM-14 module (Nellcor SpO2/12 lead ECG/IBP/Analog, FRU) |
| | 115-056539-00 | MPM-15 module (Masimo SpO2/12 lead ECG/IBP/Analog output, FRU) |
| IBP module | 115-047286-00 | IBP module |
| C.O. module | 115-047285-00 | C.O. upgrade package, no accessory |
| CO ₂ module | 115-013201-00 | ORIDION CO ₂ (package, no accessory) |
| | 115-056530-00 | 1-Slot CO ₂ module |
| | 115-056531-00 | 1-Slot CO ₂ /O ₂ module |
| AG module | 115-056533-00 | 2-Slot AG/O ₂ module |
| | 115-056532-00 | 2-Slot AG/O ₂ /BIS module |
| BIS module | 115-013194-00 | BIS module (Package, no accessory) |
| RM module | 115-047015-00 | RM module |
| SPO ₂ module | 115-056529-00 | Masimo SpO ₂ module |
| | 115-034088-00 | Nellcor SpO ₂ module (package, no accessory) |
| CCO/SvO ₂ module | 115-013196-00 | CCO/SvO ₂ module (Package, no accessory) |
| ScvO ₂ module | 115-013199-00 | SCVO ₂ module (Package, no accessory) |
| EEG module | 115-018353-00 | EEG module (Package, no accessory) |
| NMT module | 115-020916-00 | NMT module (Package, no accessory) |
| Benelink module | 115-053710-00 | Benelink module package |
| rSO ₂ module | 115-037264-00 | rSO ₂ module |
| TEMP module | 115-039492-00 | Temp module (package, no accessory) |
| Recorder module | 115-053716-00 | Recorder module |

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

For how to insert and remove parameter modules, see BeneVision N series Patient Monitor Operator's Manual (PN: 046-011259-00).

5.3 Optional Functional Assemblies

You can configure the following functional assemblies for this monitor:

| Functional Assembly | Part No. | Description |
|-----------------------|---------------|--|
| Satellite module rack | 115-033887-00 | 8-slot satellite module rack (SMR), with handle, hook, and 2 m cable |
| | 009-005122-00 | Cable connecting the monitor and the SMR, 10 m |
| Secondary display | 115-044994-00 | 22" secondary display (including the AC adapter and 2.3 m cable) |
| | 115-044993-00 | 22" secondary display (including the AC adapter and 10 m cable) |
| | 115-044997-00 | 19" secondary display (including the AC adapter and 2.3 m cable) |
| | 115-044996-00 | 19" secondary display (including the AC adapter and 10 m cable) |
| | 115-049288-00 | 22" secondary display (including the AC adapter and 5 m cable) |
| | 115-049289-00 | 19" secondary display (including the AC adapter and 5 m cable) |
| Split unit | 115-051379-00 | Split accessory material package (with the rotation function) |
| Wi-Fi | 115-033755-00 | Wi-Fi material package |
| Handle assembly | 115-034030-00 | Handle assembly (without encoder) |
| | 115-037270-00 | Handle assembly (with an encoder) |
| Main unit battery | 115-034132-00 | Battery |
| iView module | 115-055522-00 | iView module package |
| Remote controller kit | 115-045643-00 | Remote controller kit |
| 2D barcode scanner | 115-039575-00 | 2D Barcode scanner (USB) kit |
| | 115-039635-00 | 2D Barcode scanner (support RFID) kit |

This monitor is configured with wireless network functions and can be connected to network through wireless AP. Contact Mindray Technical Support for assistance in connecting to a network.

5.3.1 Installing an SMR

The SMR can be connected to the patient monitor through the SMR connector via the SMR cable. For details, see BeneVision N Series Patient Monitor Operator's Manual (PN: 046-011259-00).

5.3.2 Installing an 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

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 N Series Patient Monitor Operator's Manual (PN: 046-011259-00).

5.3.4 Setting up Wireless Network Functions

Installation and connection to a Wireless Network should be performed by Mindray Service.

5.3.5 Upgrading Handle Assembly

Refer to the corresponding section of this manual to install the handle assembly in your patient monitor.

5.3.6 Installing 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

Refer to the corresponding section of this manual to install the iView system function assembly in your patient monitor.

NOTE

- **During installation of the Main Unit Battery, iViewthe interface cover needs to be temporarily removed while installing the corresponding functional assembly in your monitor.**
 - **During installation of the handle, the corresponding handle cover needs to be replaced with the handle..**
-

6 Disassembly and Repair

6.1 Tools

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

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

6.2 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 then remove the battery. Before taking out the battery, remove the main unit housing.

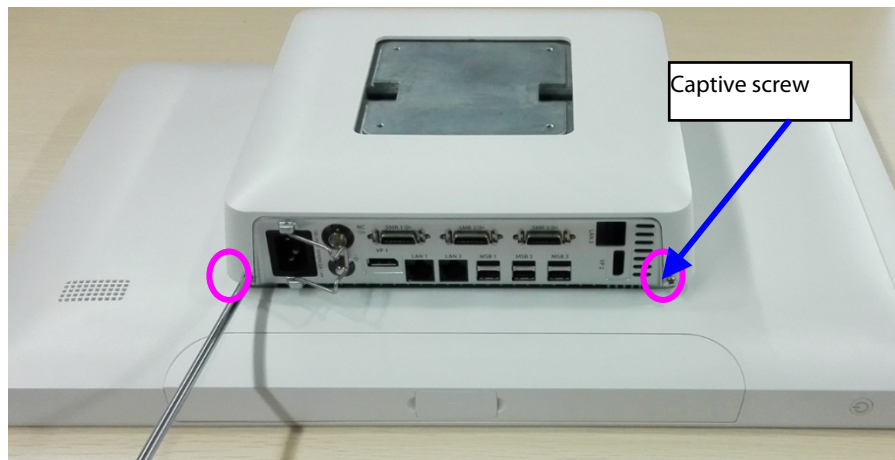
6.3 Whole Unit Disassembly

NOTE

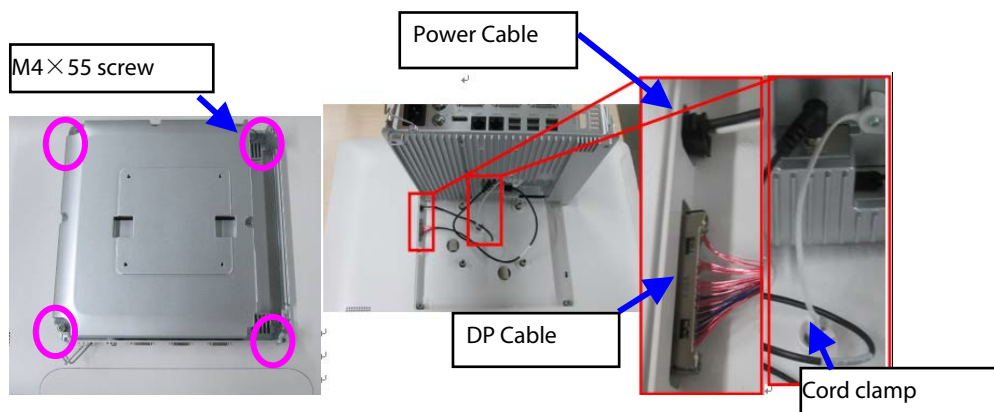
- **Before disassembly, make sure that the work surface is clean, smooth and free of debris that could cause damage to the touchscreen.**
 - **All disassembly and repairs should only be performed by qualified service personnel using anti static precautions.**
-

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

As shown in the following picture, place the monitor face down on the work surface, loosen two M3 captive screws, and then lift the main unit housing to remove it.



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

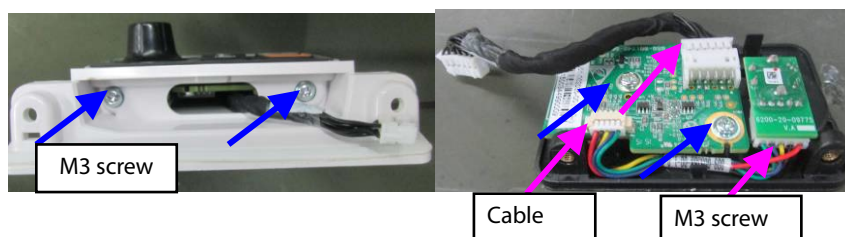


6.3.2 Removing Handle/Encoder (Optional Encoder)

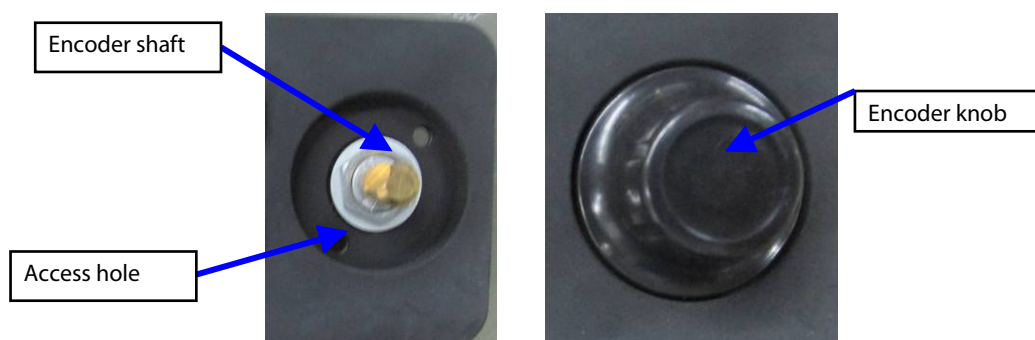
As shown in the following picture, loosen two captive screws, unplug the encoder cable, then remove the handle assembly; loosen and remove the M3X6 cross recessed pan head screws with pad, then remove the encoder assembly.



As shown in the following picture, loosen and remove the two M3X6 cross recessed pan head screws with pad, then remove the keypad board assembly; then, disconnect the cable, loosen and remove the cross recessed pan head screws with pad, then remove the encoder assembly.

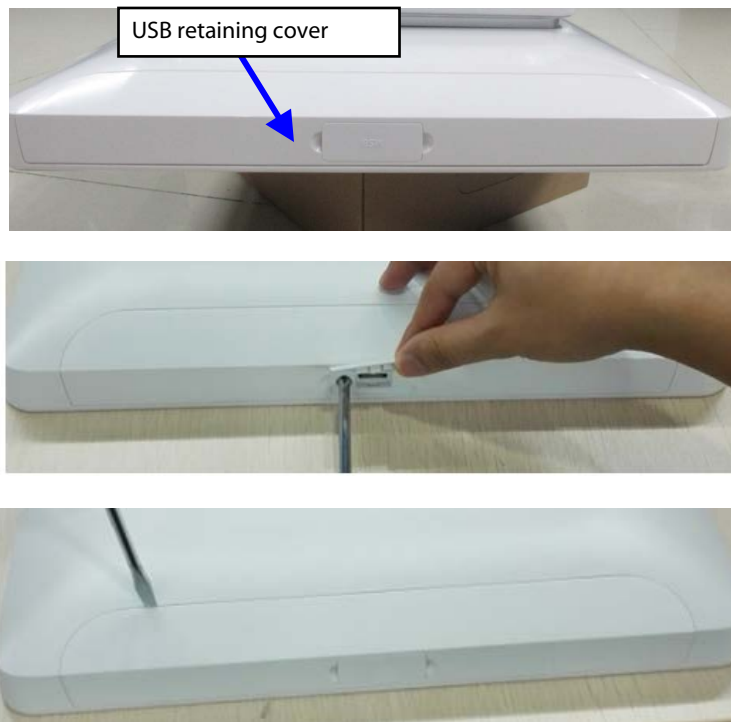


As shown in the following picture, remove the Encoder Knob by pushing it off the Encoder shaft from the back with a small punch through the access hole. Use a pair of needle nose pliers to loosen the encoder nut, then remove the encoder.



6.3.3 Removing Handle Cover

As shown in the following picture, place the monitor face down on the work surface, open the USB retaining cover, loosen and remove one M3X6 screw, and then remove the handle cover.

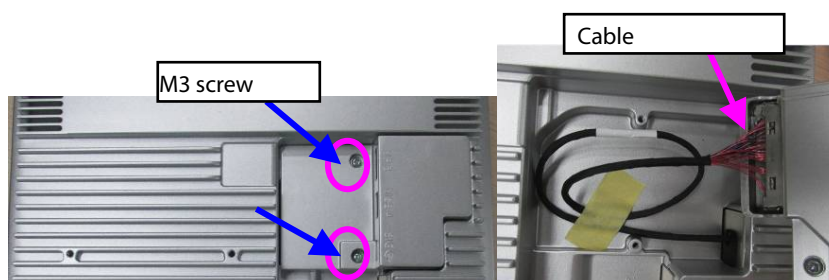


6.3.4 Removing Main Unit Housing/Main Unit Interface Adapter Board (Main Unit and Display Separated Installation)

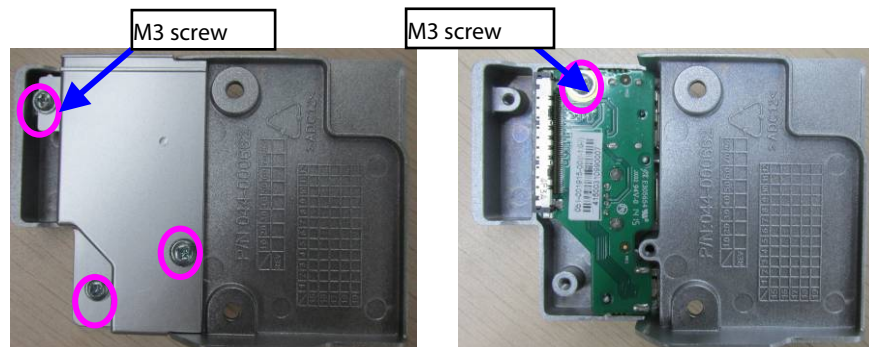
As shown in the following picture, place the monitor face down on the work surface, loosen two M3 captive screws, and then lift the main unit housing to remove it.



As shown in the following picture, turn the Main Unit over then, loosen and remove the two M3X6 cross recessed pan head screws with pad, disconnect the cable, then remove the cover for separated installation adapter of main unit.

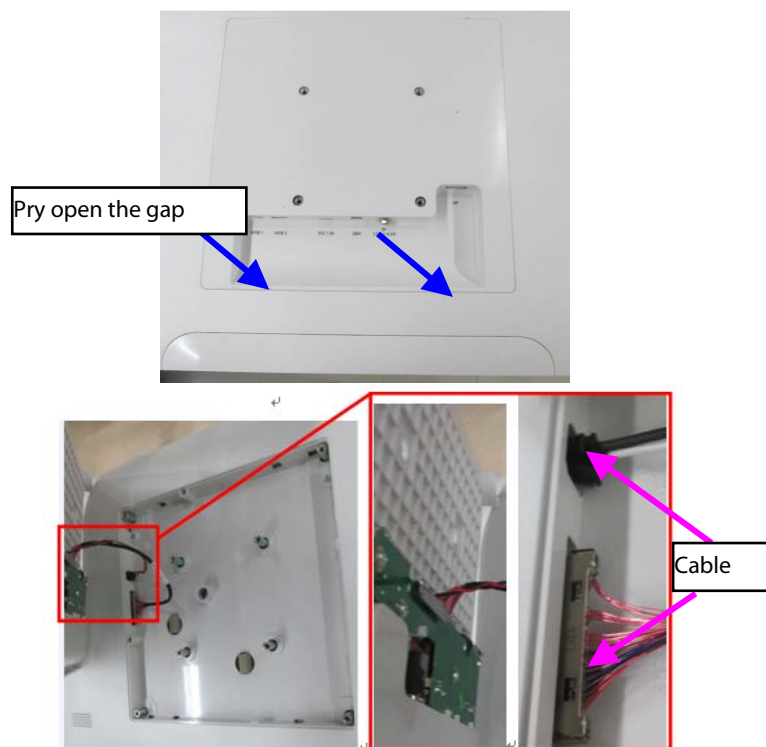


As shown in the following picture, loosen and remove the three M3X6 cross recessed pan head screws with pad, and remove the adapter board cover of main unit; loosen and remove one M3X6 cross recessed pan head screw with pad, then remove the main unit interface adapter board.

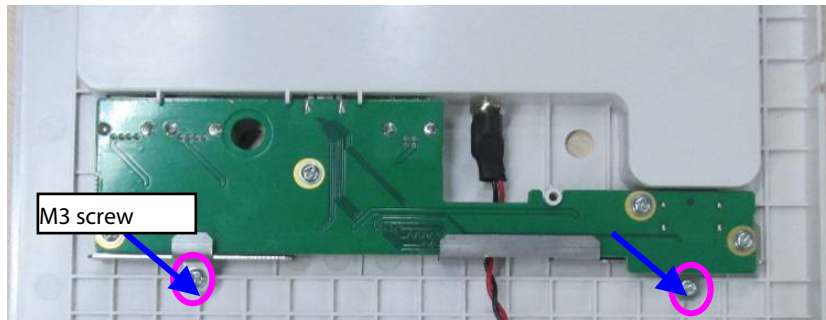


6.3.5 Removing Display Interface Adapter Board (Main Unit and Display Separated Installation)

As shown in the following picture, use a flat-bladed screwdriver to pry open the display adapter cover plate, disconnect the power cable and VP (video output) cable, then remove the display interface cover plate.



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



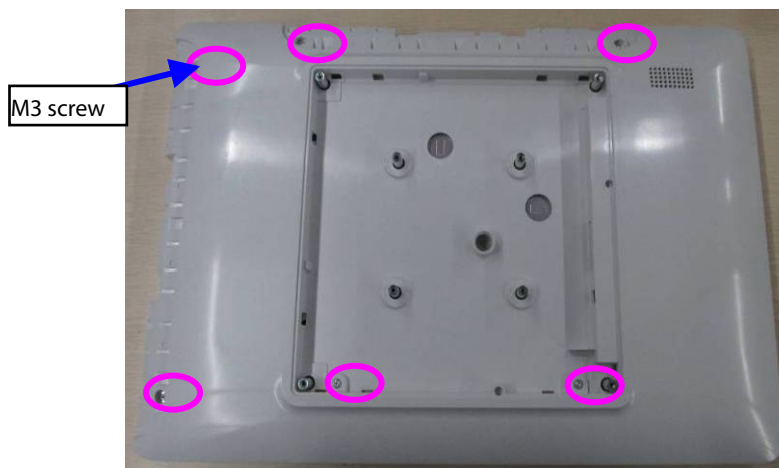
6.4 Disassembling Display (Capacitive Touchscreen)

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.

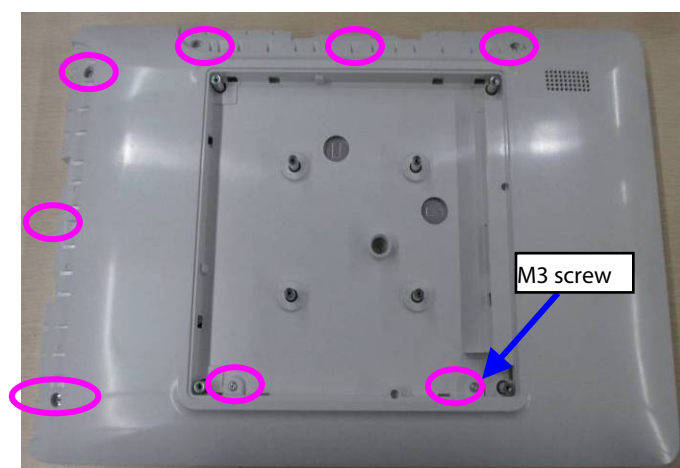
6.4.1 Removing Display Rear Housing Assembly (D19)

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



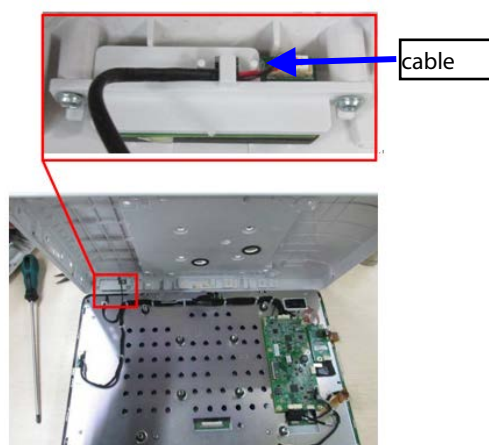
6.4.2 Removing Display Rear Housing Assembly (D22)

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



6.4.3 Removing Switch Keypad Board

As shown in the following picture, disconnect the switch keypad board cable.

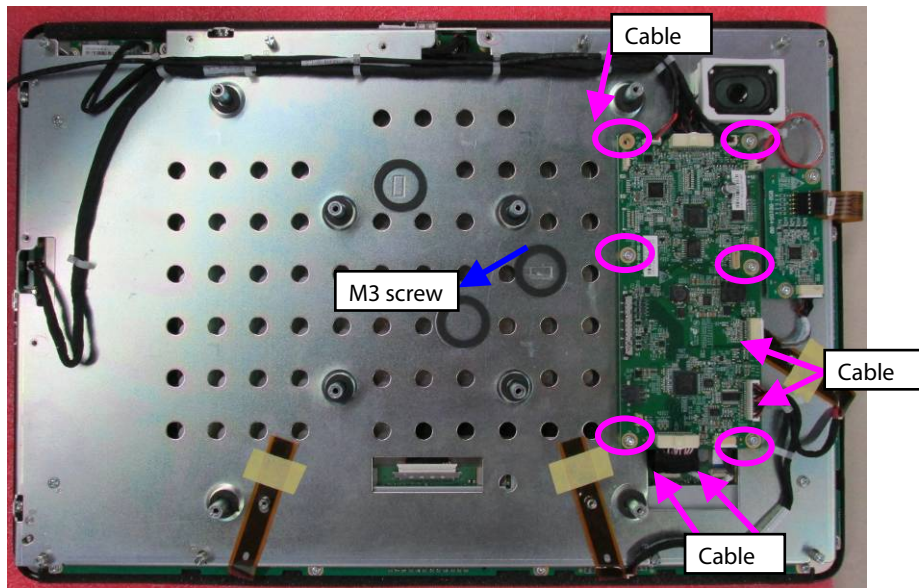


As shown in the following picture, loosen and remove the two M3X6 cross recessed pan head screws with pad, then remove the switch keypad board assembly.

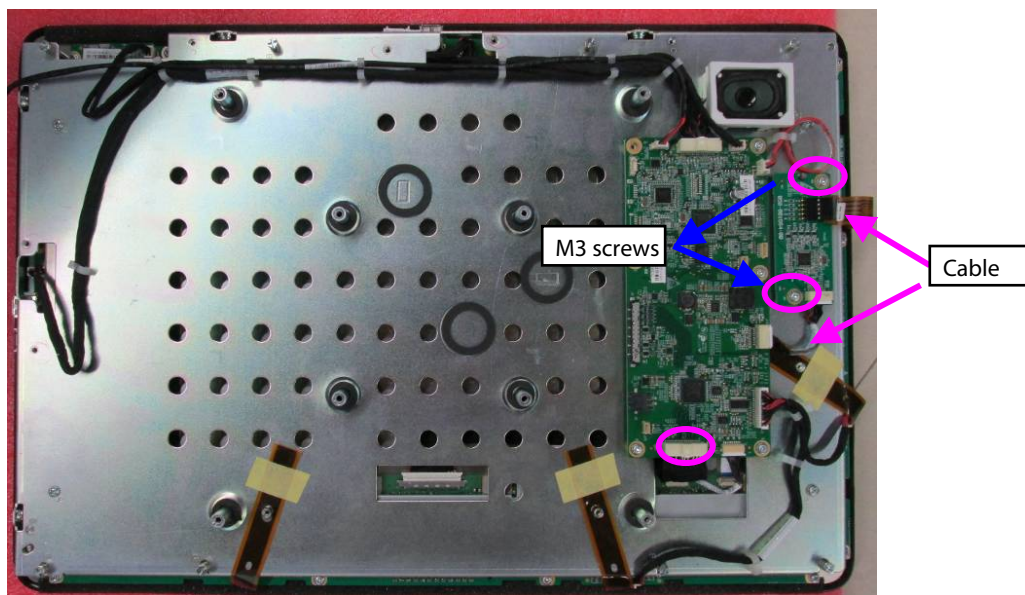


6.4.4 Removing Display Interface Board/Touchscreen Panel

As shown in the following picture, loosen and remove the six M3X6 cross recessed pan head screws with pad, disconnect the cables, then remove the display interface board.

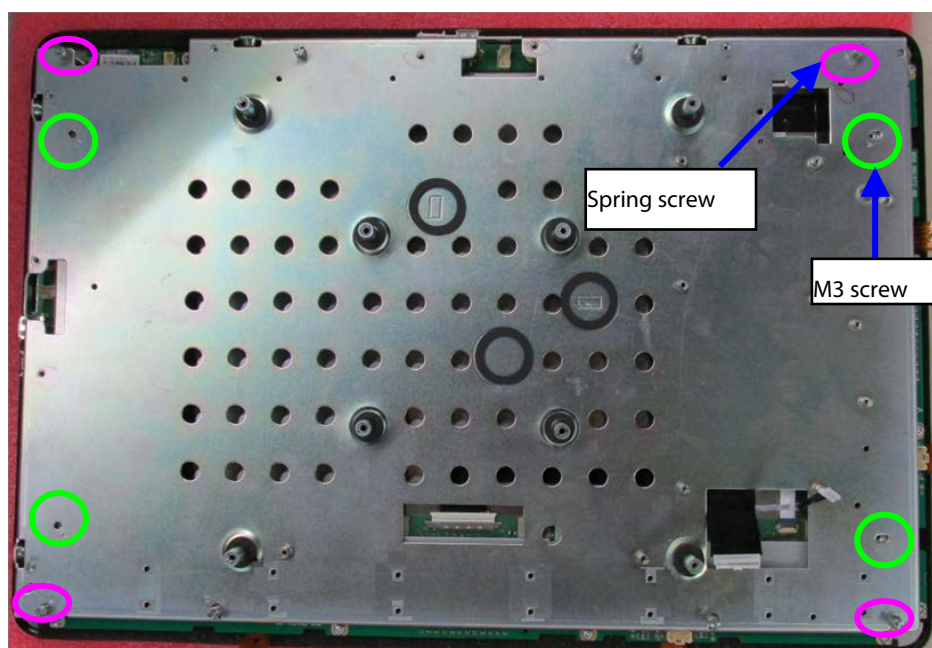


As shown in the following picture, disconnect the touchscreen cable. Loosen and remove the two M3X6 cross recessed pan head screws, then remove the touchscreen panel.

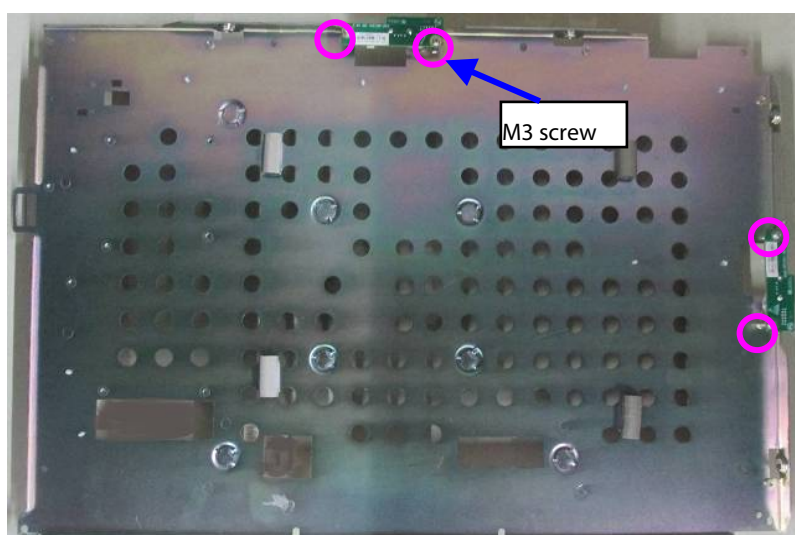


6.4.5 Removing USB Board

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



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



6.4.6 Removing LED Board/Indicator Board

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



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



6.5 Disassembling Main Unit

6.5.1 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, then remove the iView assembly.

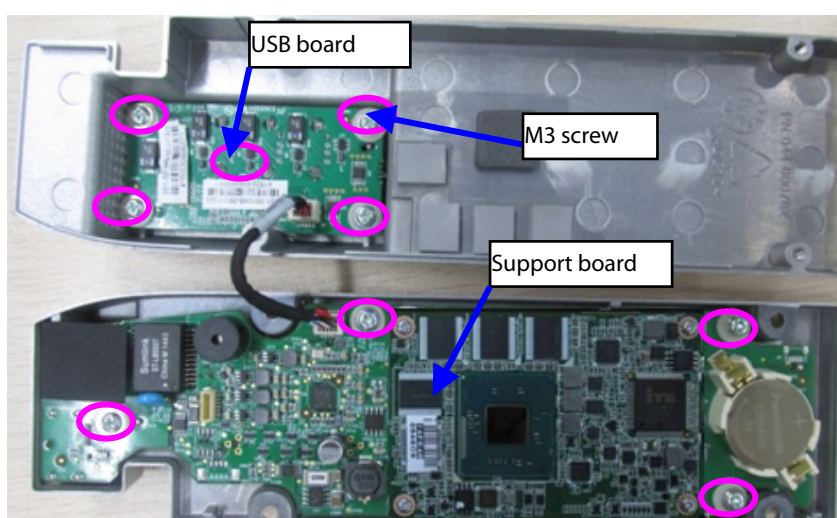


6.5.2 Removing iView Assembly Support Board/USB Interface Board (iView Assembly Optional)

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



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



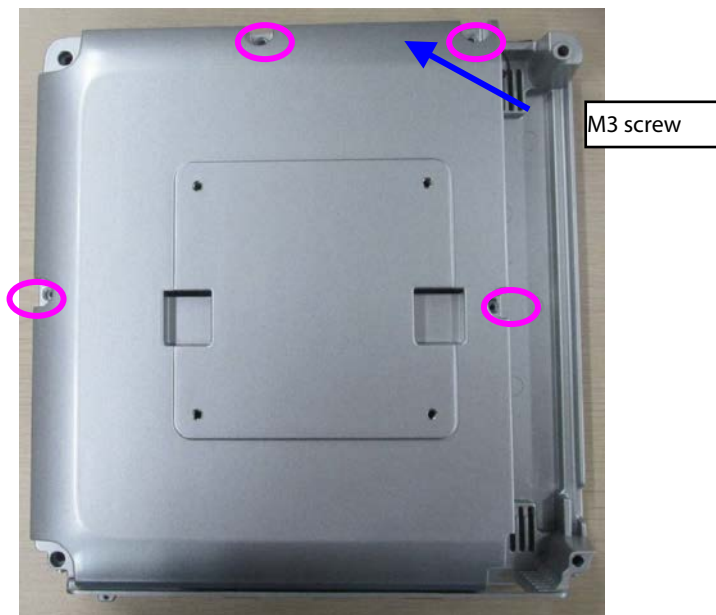
6.5.3 Removing Battery

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

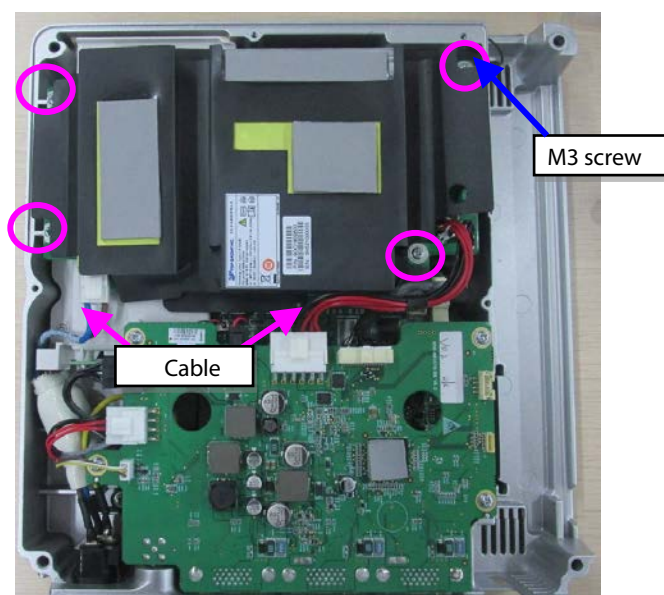


6.5.4 Removing ACDC Power Board

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.

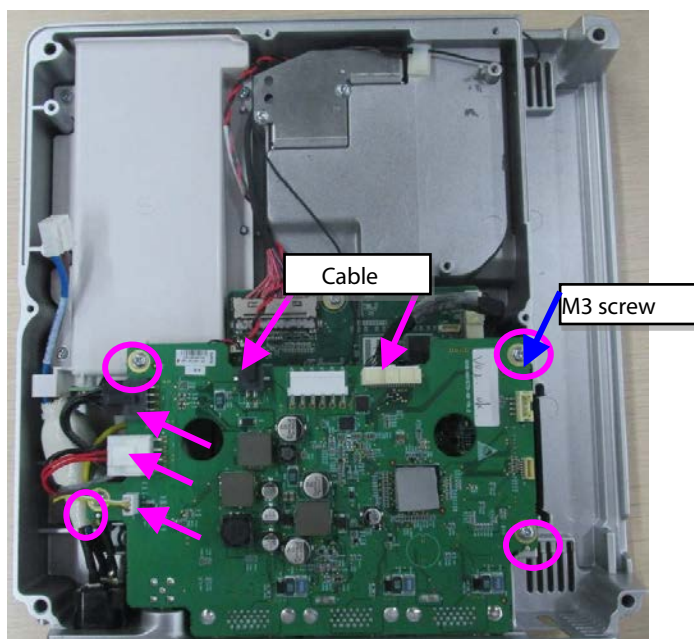


As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, disconnect the power cable, then remove the ACDC power board.

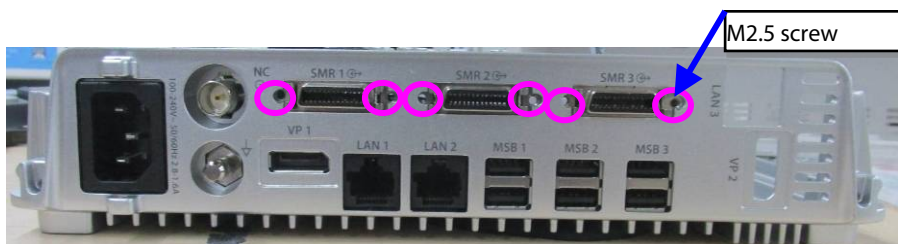


6.5.5 Removing DCDC Power Management Board

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

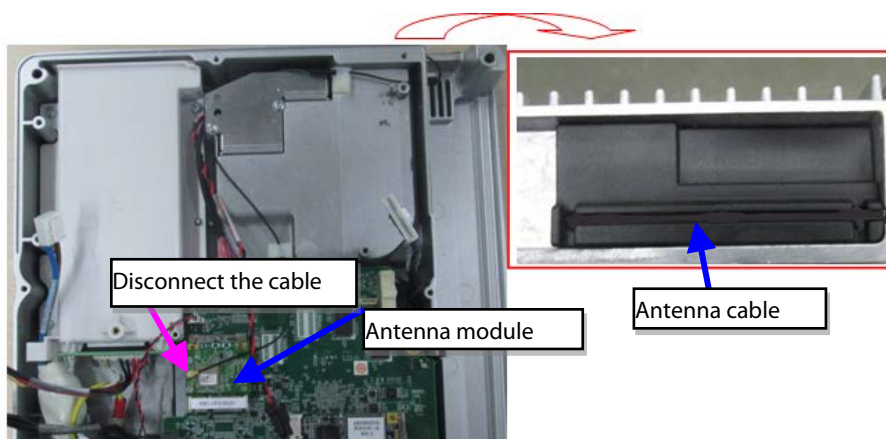


As shown in the following picture, loosen and remove the six small M2.5 pan head screws, then remove the DCDC power management board.



6.5.6 Removing Antenna Module and Antenna Cable

As shown in the following picture, disconnect the antenna cable from the Wi-Fi module, then remove the antenna module and antenna cable.



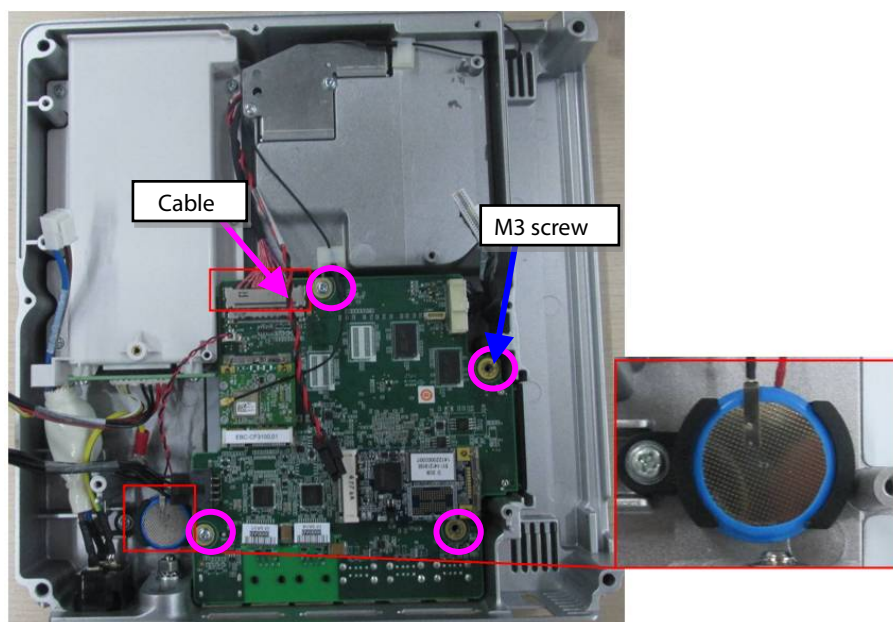
6.5.7 Removing SSD Hard Disk

As shown in the following picture, remove the SSD hard disk.



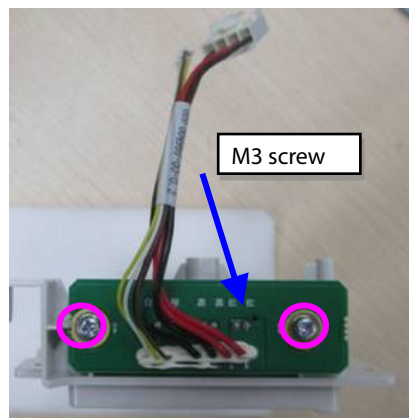
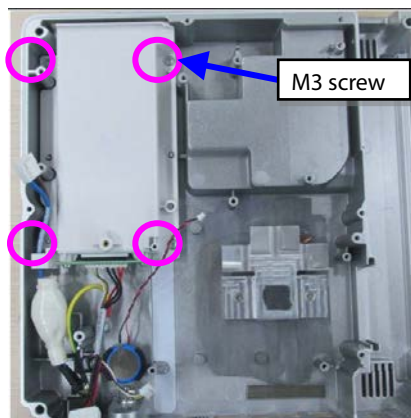
6.5.8 Removing Main Control Board

As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, remove the button battery from it's holder, then remove the main control board.



6.5.9 Removing Battery Backplane

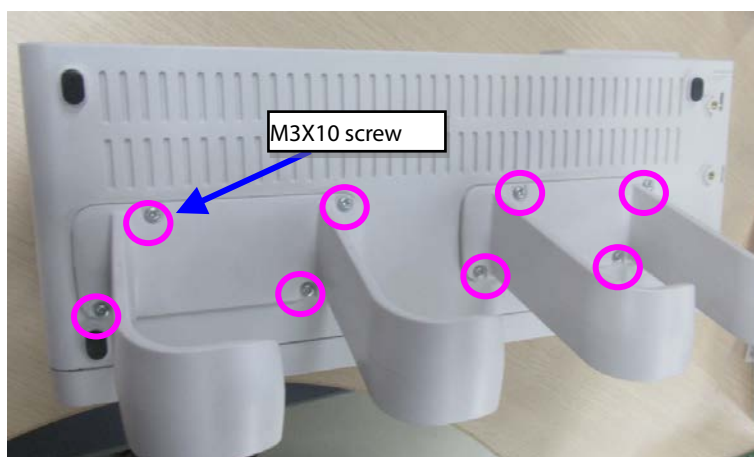
As shown in the following picture, loosen and remove the four M3X6 cross recessed pan head screws with pad, then remove the battery cavity assembly; remove the two M3X6 cross recessed pan head screws with pad, then remove the battery backplane.



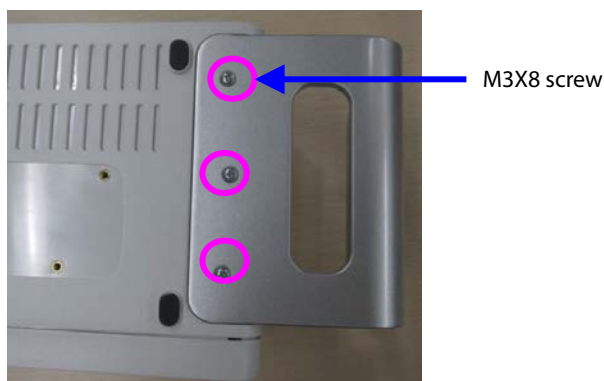
6.6 Disassembling the Module Rack

6.6.1 Disassembling 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 M3X8 cross recessed countersunk head screws, and remove the handle.



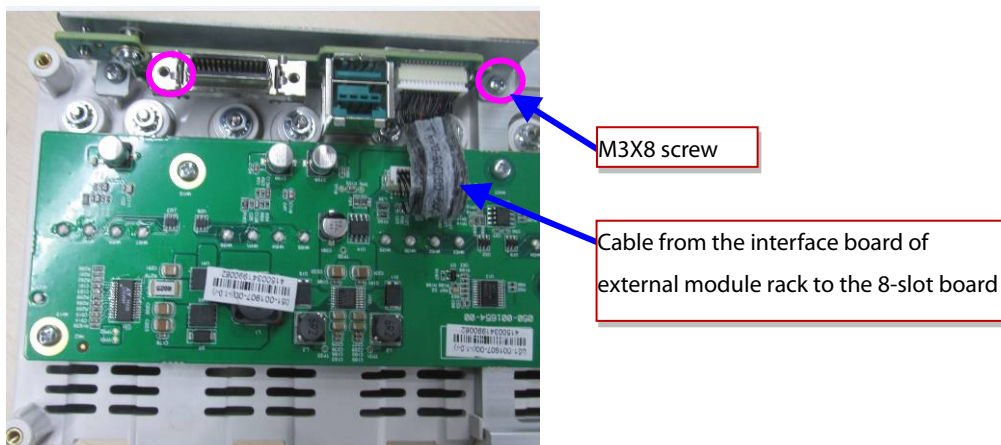
6.6.2 Disassembling the Rear Case of Module Rack

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.



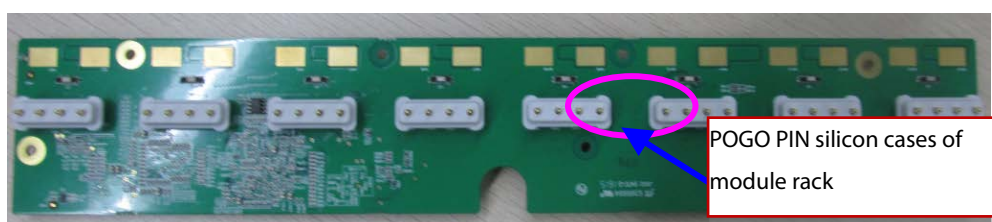
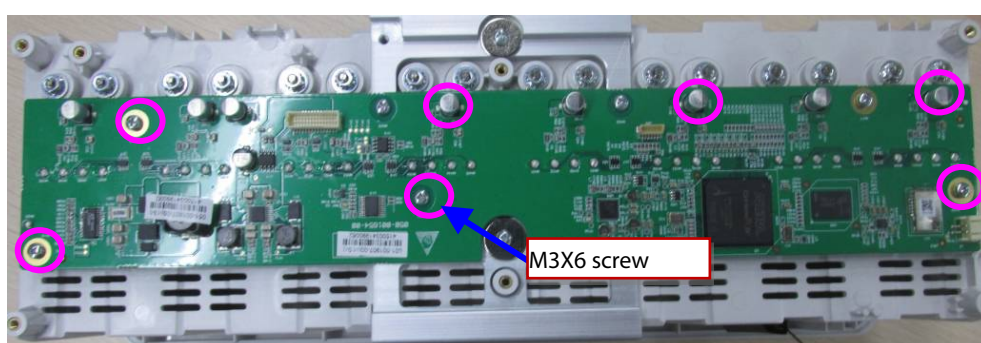
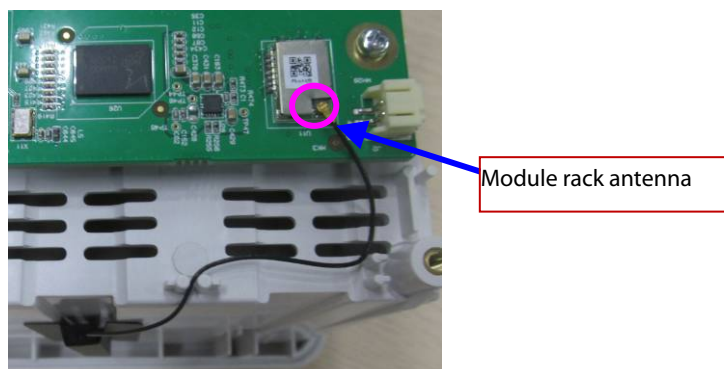
6.6.3 Disassembling the Module Rack Interface Board

Loosen and remove the two M3X8 cross recessed pan head screws, disconnect the cable between the interface board and the infrared backplane, and then remove the interface board.



6.6.4 Disassembling the Infrared Backplane of Module Rack

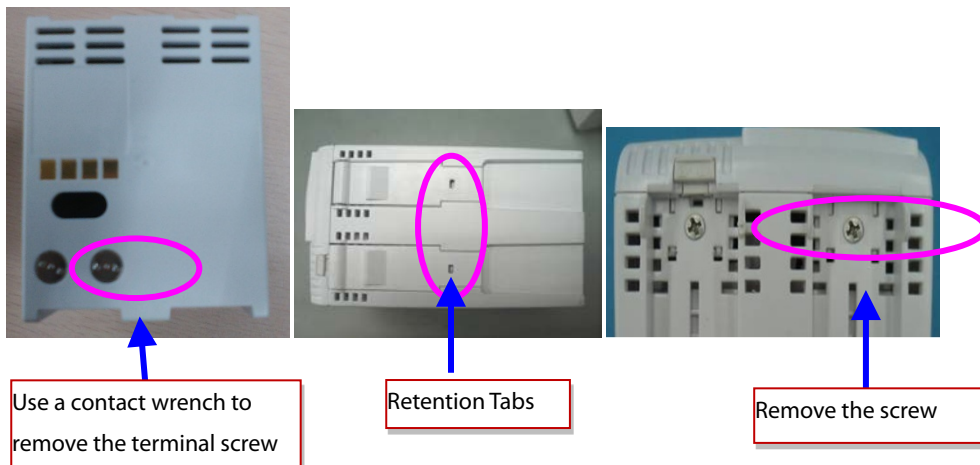
Disconnect the cable between the module rack antenna and the infrared backplane, loosen and remove the seven M3X8 cross recessed pan head screws on the infrared backplane, then remove the eight POGO PIN silicon cases of module rack.



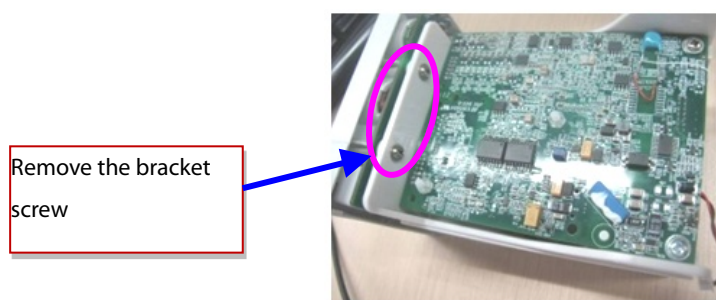
6.7 Disassembling the M51C Module

6.7.1 Disassembling the Front Panel Assembly

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

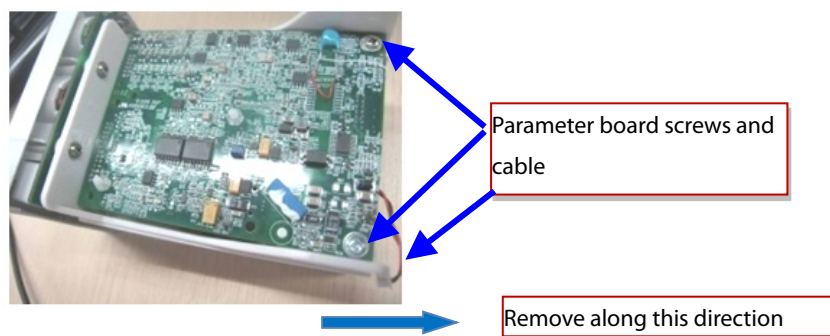


As shown in the following figure, loosen and remove the screw between the front panel and the bracket, and unplug the air tube at the air nozzle. Then the front panel can be removed.



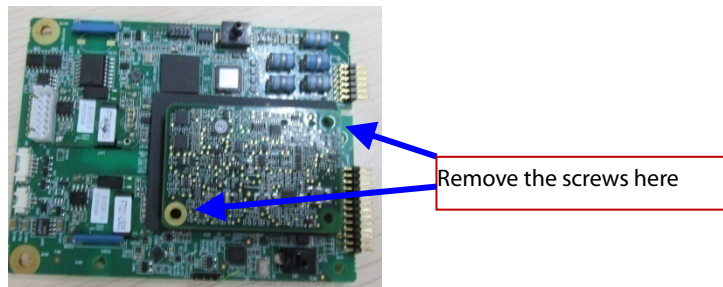
6.7.2 Disassembling the Parameter Board

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



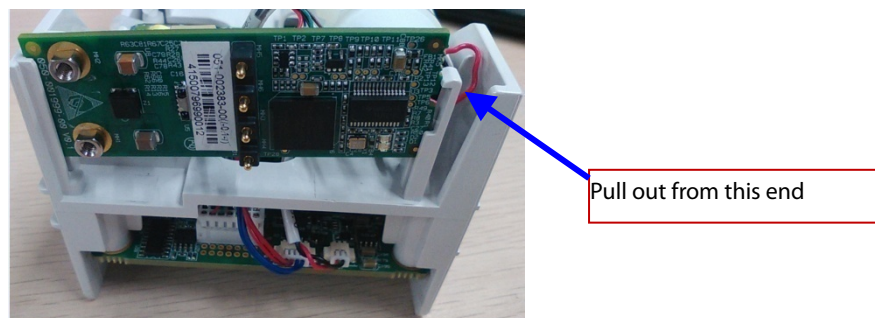
6.7.3 Disassembling the SpO2 board

As shown in the following figure, remove the SpO₂ board screws, and then remove the blood oxygen board.



6.7.4 Disassembling the Infrared Board

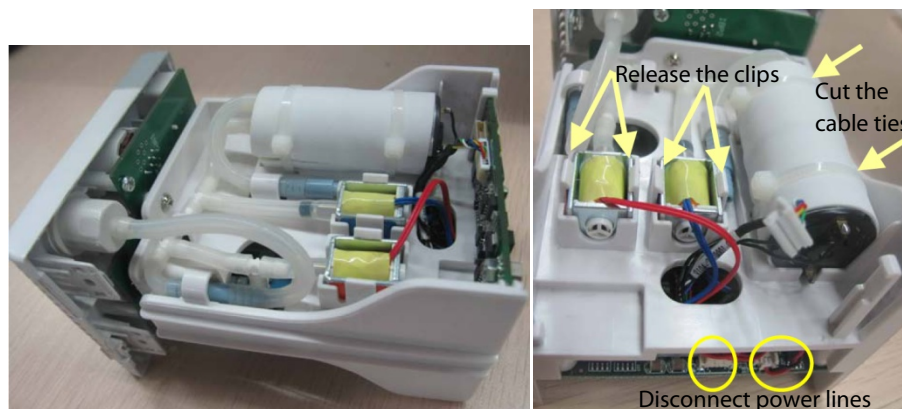
As shown in the following figure, disconnect the infrared board cable, and then remove the infrared board.



6.7.5 Removing the Pump and Valve

Cut the cable tie, disconnect the pump power cable and NIBP air tube, and then remove the pump.

disconnect the valve power cable and NIBP air tube, use a flat-bladed screwdriver to release the clips on the sides of the valve, and then remove the valve assembly.

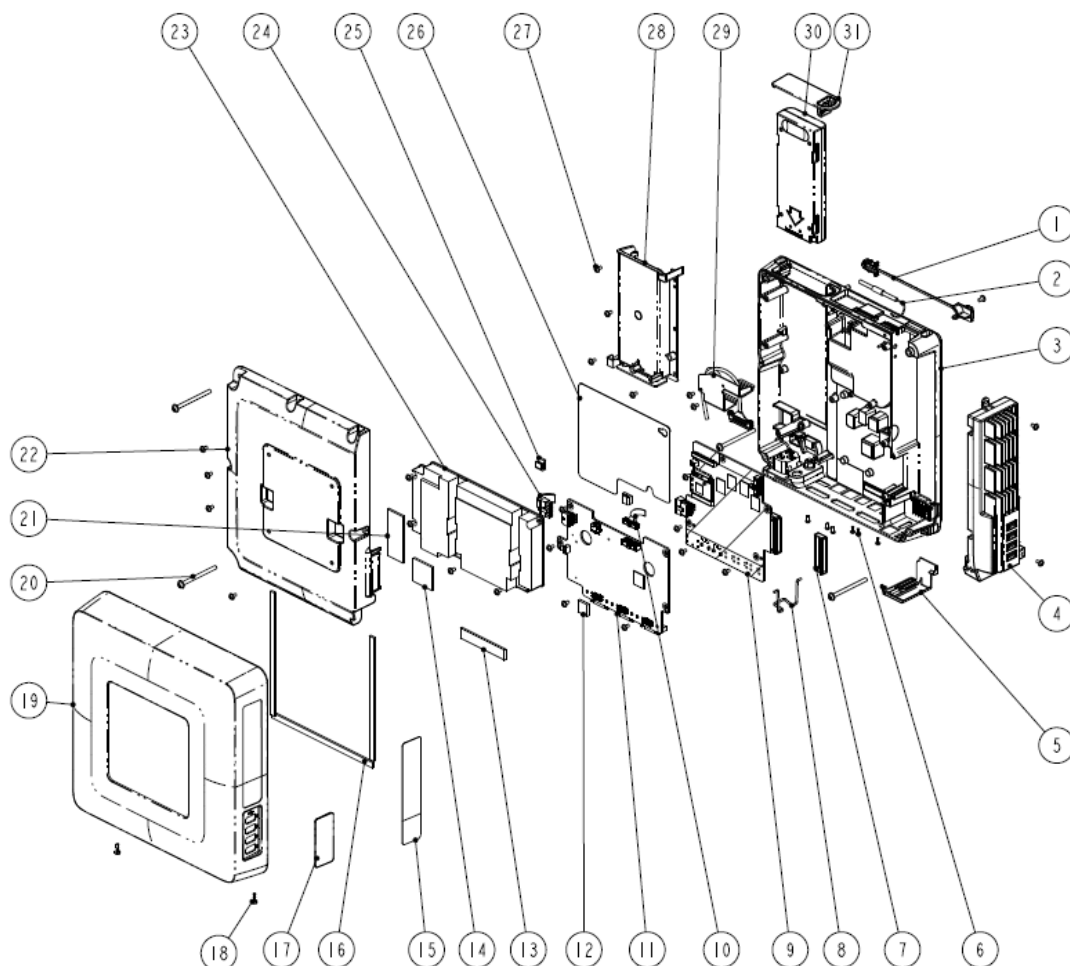


FOR YOUR NOTES

7 Parts

7.1 Main Unit

7.1.1 Exploded View



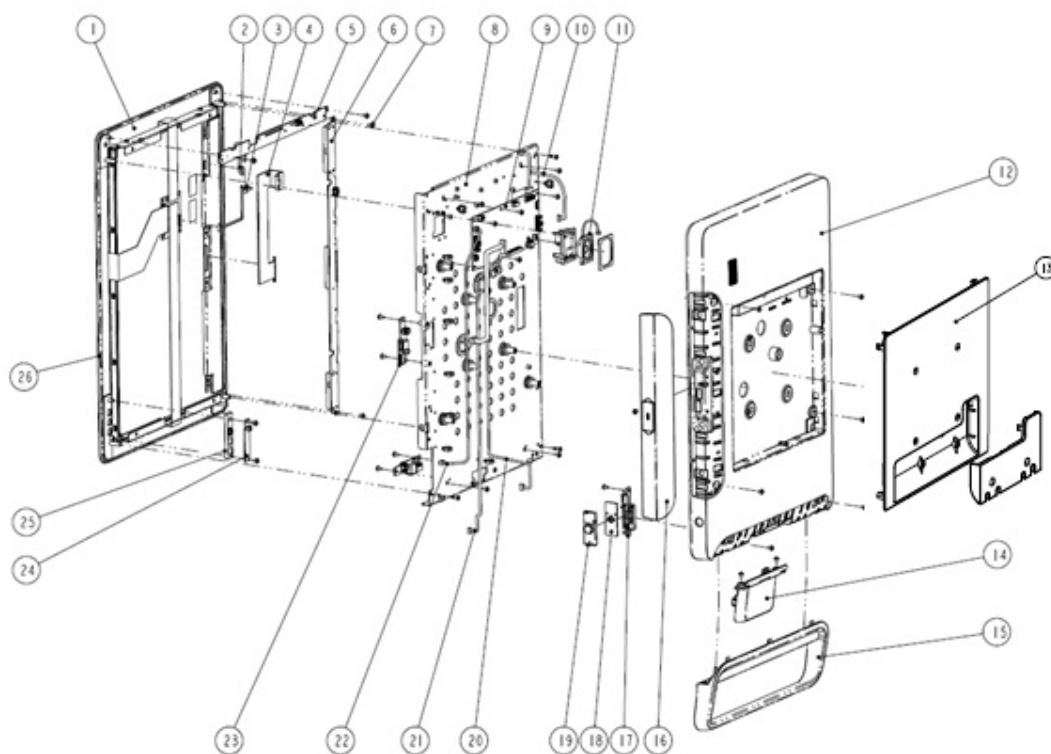
7.1.2 Parts List

| ITEM NO. | Description | Qty | FRU part number |
|----------|--|-----|-----------------|
| 1 | Cable protection belt | 1 | / |
| 2 | WiFi antenna 2.4GHz and 5GHz dual frequencies | 1 | 024-000717-00 |
| 3 | Main unit base assembly | 1 | 115-037485-00 |
| 4 | IVIEW module | 1 | 115-049593-00 |
| 5 | DP port decoration cover | 1 | 043-005815-01 |
| 6 | Small cross recessed pan head screw GB/T823-1988 M2.5X6 plated with green color zinc | 6 | / |
| 7 | Rack female receptacle waterproof jacket | 1 | / |
| 8 | Power plug anti-pull hook | 1 | / |

| ITEM NO. | Description | Qty | FRU part number |
|----------|--|-----|-----------------|
| 9 | Main control board PCBA Bay-Trail E3827 2GDDR | 1 | 115-037490-00 |
| 10 | Signal cable from the main control board to the main unit interface and DC board | 1 | 009-005098-00 |
| 11 | Main unit interface and DC-DC board PCBA | 1 | 115-037491-00 |
| 12 | Main unit FPGA heat conducting pad | 1 | / |
| 13 | AC-DC heat conducting pad 3 | 1 | / |
| 14 | AC-DC heat conducting pad 2 | 1 | / |
| 15 | N22_N19 main unit label (Chinese) | 1 | / |
| 16 | Main unit housing waterproof foam | 3 | 115-037486-00 |
| 18 | CAPTIVE-SCREW | 2 | |
| 19 | Main unit housing | 1 | |
| 17 | USB port decoration cover | 1 | 043-009126-00 |
| 20 | Stainless steel cross recessed pan head screw GB9074.1-88 M4X55 with pad, passivated | 4 | / |
| 21 | AC-DC heat conducting pad 1 | | / |
| 22 | Upper cover of main unit | 1 | 044-000660-00 |
| 23 | Power supply 90-264VAC 16V/10A | 1 | 022-000249-00 |
| 24 | Power cord from the main control board to the main unit interface and DCDC board | 1 | 009-004996-00 |
| 25 | Cable fixing. Viscose type fixing base GCF-063 | 2 | / |
| 26 | ACDC insulating sheet 1 | 1 | / |
| 27 | Small cross recessed pan head GB9074.5-88 M3X6 with pad and plated with green color zinc | 25 | / |
| 28 | Battery cavity assembly | 1 | / |
| 29 | Main unit interface adapting assembly | 1 | / |
| 30 | Lithium battery 11.3V 5600mAh LI23I003A | 1 | 115-034132-00 |
| 31 | Main unit battery door (overmold) | 1 | 043-006168-00 |

7.2 D19 Display Assembly (Capacitive Screen)

7.2.1 Exploded View



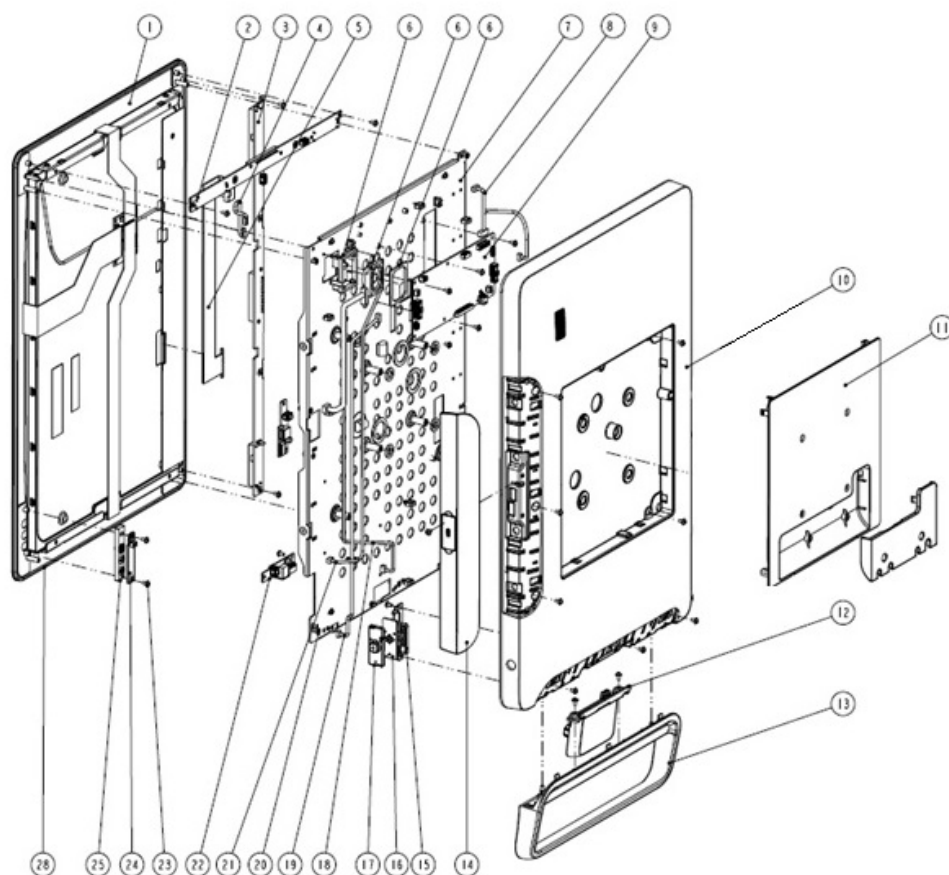
7.2.2 Parts List

| ITEM NO. | Description | Qty | FRU part number |
|----------|---|------|-----------------|
| 1 | 19"LCD Touch Screen UV | 1 | 115-045001-00 |
| | D19 LCD transfer bracket | 2 | |
| | D19 touchscreen plate-1/ D19touchscreen adhesive-1 | 1 | |
| | D19touchscreen plate-2/ D19touchscreen adhesive-2 | 1 | |
| | D19touchscreen plate-3/ D19touchscreen adhesive-3 | 1 | |
| | D19touchscreen plate-4/ D19touchscreen adhesive-4 | 1 | |
| | D19 cosmetic gasket | 1 | |
| | Tape for display gasket | 0.04 | |
| | Small cross recessed pan head GB9074.5-88 M3X6 with pad | 4 | |
| 2 | 19-inch LCD backlight cable | 1 | 009-005113-00 |
| 3 | DIB to PCB | 1 | 009-006879-00 |
| 4 | 19-inch LCD LVDS signal cable | 1 | 009-005110-00 |
| 5 | 1 9inch vertical LED board PCBA | 1 | 051-001925-01 |
| 6 | 19 inch horizontal LED board PCBA | 1 | 051-001924-00 |
| 7 | Small cross recessed pan head GB9074.5-88 M3X6 with pad | 28 | / |
| 8 | D19 main bracket | 1 | / |

| ITEM NO. | Description | Qty | FRU part number |
|----------|---|-----|-----------------|
| 9 | Display interface board PCBA (FRU) | 1 | 115-044999-00 |
| 10 | Alarm LED board interconnection line | 1 | 009-005109-00 |
| 11 | Speaker bracket | 1 | 115-037489-00 |
| | Speaker | 1 | |
| | Speaker pad | 1 | |
| 12 | D19 rear housing | 1 | 043-005820-02 |
| 13 | Display rear housing cover assembly | 1 | 043-006465-01 |
| | Cable management cover (silkscreen) | 1 | 043-008962-00 |
| 14 | Encoder assmebly | 1 | 115-050303-00 |
| 15 | Handle assembly (without an encoder) | 1 | 115-033716-00 |
| 16 | Long side handle cover | 1 | 115-035457-00 |
| | Display USB cover (overmold) | 1 | |
| | Short side handle cover (D19) | 1 | |
| 17 | Key seat | 1 | 043-006119-00 |
| 18 | Switch keypad board PCBA | 1 | 051-001920-00 |
| 19 | Switch key assembly | 1 | 049-001031-00 |
| 20 | USB interface board interconnection line | 1 | 009-005106-00 |
| 21 | Display interface board and keypad board interconnection line | 1 | 009-005104-00 |
| 22 | Display interface board and indicator & light sensor board line | 1 | 009-005124-00 |
| 23 | USB interface board PCBA | 2 | 051-001933-01 |
| 24 | Indicator and light intensity sensor board PCBA | 1 | 051-001918-00 |
| 25 | Indicator light lamp shade | 1 | 049-000872-00 |
| 26 | D19 ornamental belt(FRU) | 1 | 115-045003-00 |

7.3 D22 Display Assembly (Capacitive Screen)

7.3.1 Exploded View



7.3.2 Parts List

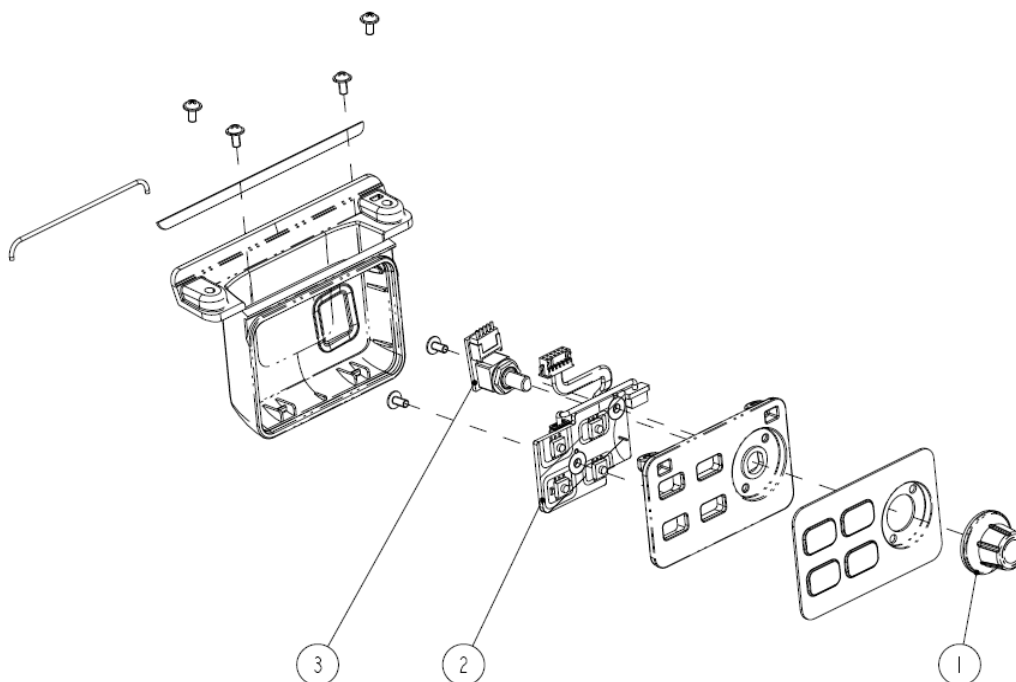
| ITEM NO. | Description | Qty | FRU part number |
|----------|---|------|-----------------|
| 1 | 22"LCD Touch Screen UV | 1 | 115-045000-00 |
| | D22 LCD transfer bracket | 2 | |
| | D22 touchscreen plate -1/ D22 touchscreen adhesive -1 | 1 | |
| | D22 touchscreen plate -2/ D22 touchscreen adhesive -2 | 1 | |
| | D22 touchscreen plate -3/ D22 touchscreen adhesive -3 | 1 | |
| | D22 touchscreen plate -4/ D22 touchscreen adhesive -4 | 1 | |
| | D22 cosmetic gasket | 1 | |
| | Tape for display gasket | 0.04 | |
| | Small cross recessed pan head GB9074.5-88 M3X6 with pad | 4 | |

| ITEM NO. | Description | Qty | FRU part number |
|----------|---|-----|-----------------|
| 2 | 22 inch vertical LED board PCBA | 1 | 051-001923-00 |
| 3 | 22 inch horizontal LED board PCBA | 1 | 051-001922-00 |
| 4 | 22 inch LCD backlight cable | 1 | 009-005112-00 |
| 5 | 22-inch LCD LVDS signal cable | 1 | 009-005111-00 |
| 6 | Speaker bracket | 1 | 115-037489-00 |
| | Speaker | 1 | |
| | Speaker pad | 1 | |
| 7 | D22 main bracket | 1 | 042-013329-01 |
| 8 | Alarm LED board interconnection line | 1 | 009-005109-00 |
| 9 | Display interface board PCBA (FRU) | 1 | 115-044999-00 |
| 10 | D22 rear housing | 1 | 043-005871-02 |
| 11 | Display rear housing cover assembly | 1 | 043-006465-01 |
| | Cable management cover (silkscreen) | | 043-008962-00 |
| 12 | Encoder assembly | 1 | 115-050303-00 |
| 13 | Handle assembly (without an encoder) | 1 | 115-033716-00 |
| 14 | 22 inch handle cover kit | 2 | 115-035456-00 |
| 15 | Key seat | 1 | 043-006119-00 |
| 16 | Switch keypad board PCBA | 1 | 051-001920-00 |
| 17 | Switch key assembly | 1 | 049-001031-00 |
| 18 | USB interface board interconnection line | 1 | 009-005106-00 |
| 19 | Display interface board and keypad board interconnection line | 1 | 009-005104-00 |
| 20 | Heater fix screw | 4 | 041-008273-00 |
| 21 | Display interface board and indicator & light sensor board line | 1 | 009-005124-00 |
| 22 | USB interface board PCBA | 2 | 051-001933-01 |
| 23 | Small cross recessed pan head GB9074.5-88 M3X6 with pad | 30 | M04-004012--- |

| ITEM NO. | Description | Qty | FRU part number |
|----------|---|-----|-----------------|
| 24 | Indicator and light intensity sensor board PCBA | 1 | 051-001918-00 |
| 25 | Indicator light lamp shade | 1 | 049-000872-00 |
| 26 | D22 cosmetic gasket | 1 | 049-000969-01 |

7.4 Encoder Assembly

7.4.1 Exploded View

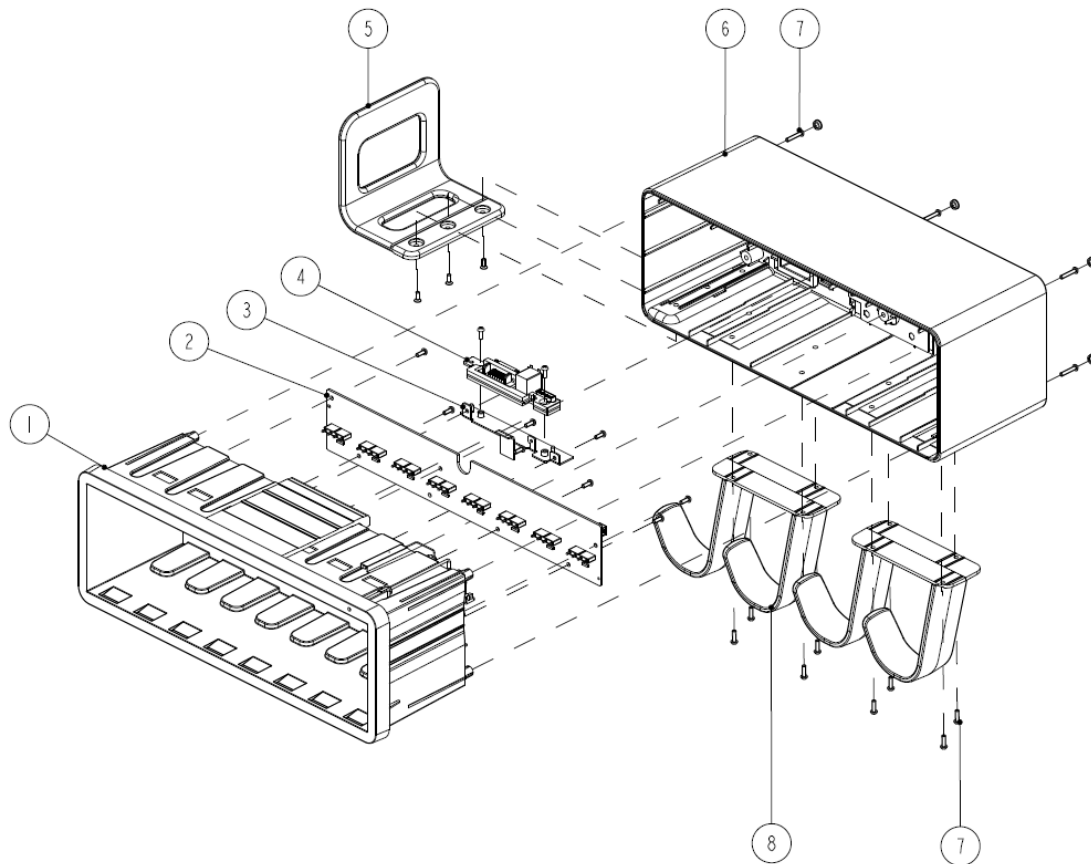


7.4.2 Parts List

| ITEM NO. | Description | Qty | FRU part number |
|----------|---|-----|-----------------|
| 1 | D22 knob | 1 | 115-050303-00 |
| 2 | Encoder interface and keypad board PCBA | 1 | |
| 3 | Copper shaft encoder fixing board | 1 | |

7.5 Module Rack

7.5.1 Exploded View

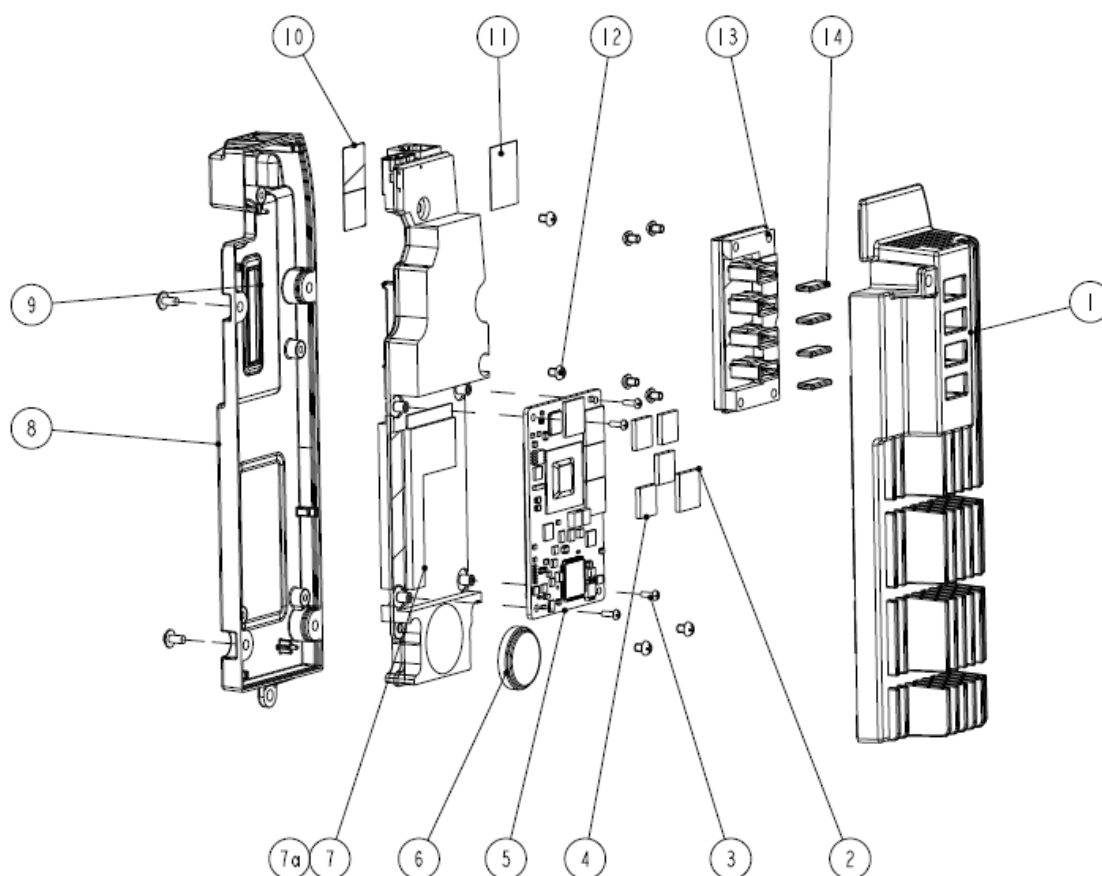


7.5.2 Parts List

| ITEM NO. | Description | Qty | FRU part number |
|----------|--|-----|-----------------|
| 1 | Front housing silkscreen of module rack | 1 | 043-008617-00 |
| 2 | 8-slot PCBA of external module rack | 1 | 051-001907-00 |
| 3 | Interface board fixing sheet metal | 1 | / |
| 4 | Interface board PCBA of external module rack | 1 | 051-001908-00 |
| 5 | Module rack cuff bracket | 1 | 115-033914-00 |
| 6 | Rear housing silkscreen of module rack | 1 | 043-008616-00 |
| 7 | Cross recessed pan head screw GB/T818-2000 M3X16 plated with green color zinc | 1 | / |
| 8 | Module rack cable hook | 1 | 115-033911-00 |

7.6 iVIEW Module

7.6.1 Exploded View



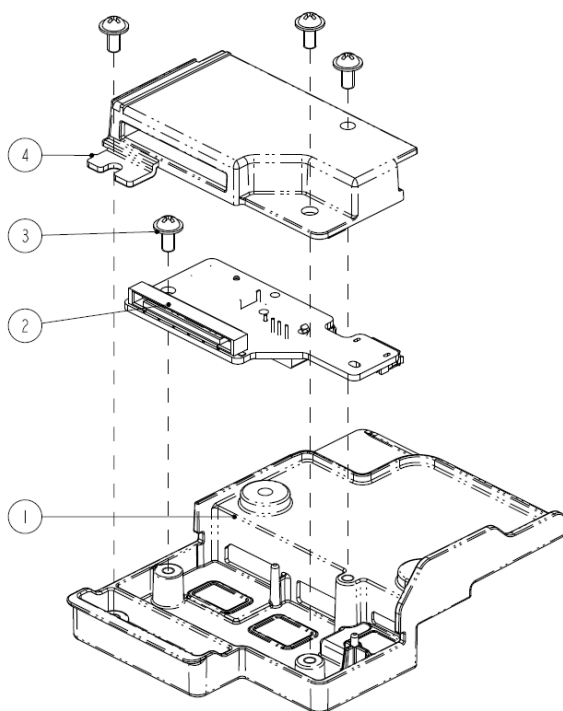
7.6.2 Parts List

| ITEM NO. | Description | Qty | FRU part number |
|----------|--|-----|-----------------|
| 1 | iVIEW front housing | 1 | / |
| 2 | iVIEW CPU heat conducting pad | 1 | / |
| 3 | Cross recessed pan head screw GB/T818-2000 M2X6 plated with green zinc | 4 | / |
| 4 | iVIEW memory heat conducting pad | 4 | / |
| 5 | Computer module Celeron J1900 | 1 | 023-001497-00 |
| 6 | Button battery | 1 | / |
| 7 | iView support board PCBA | | 051-003028-00 |
| 7a | SSD 128GB MLC mSata | 1 | 023-001329-00 |
| 8 | iVIEW rear housing | 1 | / |
| 9 | Cross recessed pan head GB9074.5-88 M3X6 with pad and plated with green zinc | 4 | / |
| 10 | iVIEW network port insulating sheet | 1 | / |
| 11 | Network port insulating sheet | 1 | / |

| ITEM NO. | Description | Qty | FRU part number |
|----------|--|-------|-----------------|
| 12 | Cross recessed pan head screw GB/T818-2000 M3X4 plated with green zinc | 8 | / |
| 13 | iView USB interface board PCBA | 1 | 051-001948-00 |
| 14 | Conductive foam 2.0*7.0mm | 0.06m | / |

7.7 Main Unit Separated Installation Auxiliary Accessories

7.7.1 Exploded View

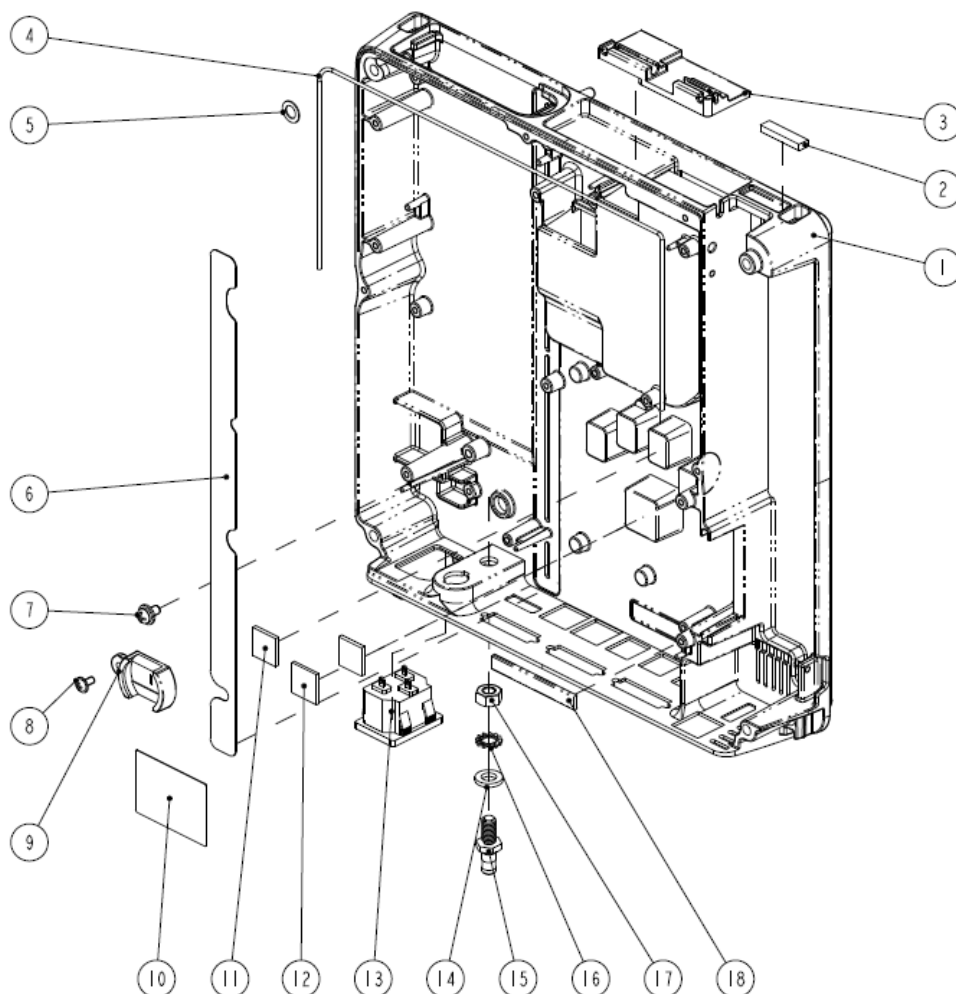


7.7.2 Parts List

| ITEM NO. | Description | Qty | FRU part number |
|----------|--|-----|-----------------|
| 1 | Adapter board mounting bracket | 1 | / |
| 2 | Main unit interface adapter board PCBA | 1 | 051-001915-00 |
| 3 | M3X6_GB9074_5 small cross recessed pan head with pad | 4 | / |
| 4 | Adapter board cover of main unit | 1 | / |

7.8 Main Unit Base Assembly

7.8.1 Exploded View



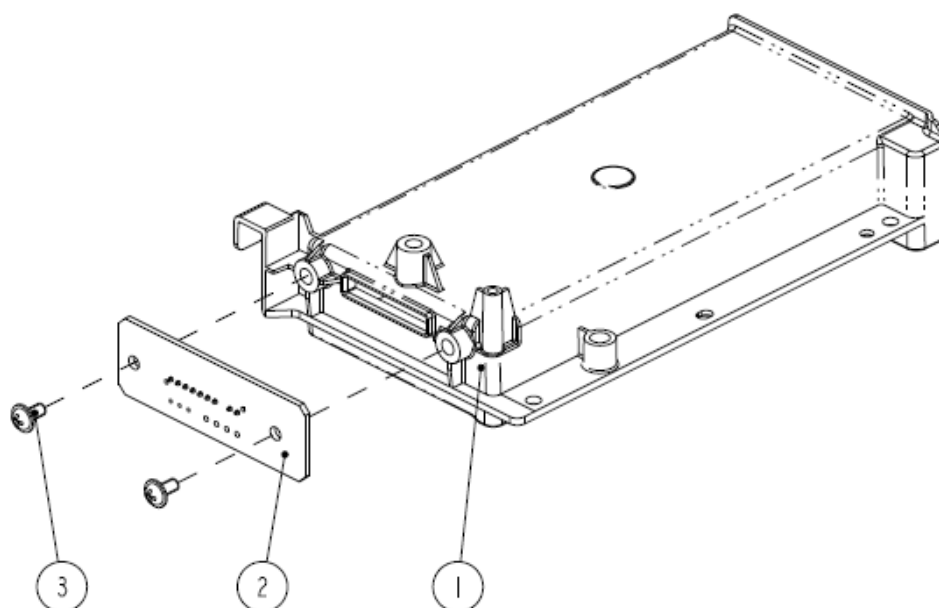
7.8.2 Parts List

| ITEM NO. | Description | Qty | FRU part number |
|----------|--|-----|-----------------|
| 1 | Main unit bracket silkscreen | 1 | 115-037485-00 |
| 2 | Main unit bracket waterproof foam | 1 | |
| 3 | Antenna fixing frame | 1 | |
| 4 | Rubber tube. 1.6mmODX0.8mmID | 1 | |
| 5 | Waterproof pad | 1 | |
| 6 | Main unit bracket overlay | 1 | |
| 7 | Small cross recessed pan head screw assembly GB/T9074.8 M4X8 plated with green color zinc | 1 | |
| 8 | Small cross recessed pan head GB9074.5-88 M3X6 with pad and plated with green color zinc | 1 | |

| ITEM NO. | Description | Qty | FRU part number |
|----------|---|-------|-----------------|
| 9 | RTC battery fixing part | 1 | |
| 10 | Network port insulating sheet of main unit | 1 | |
| 11 | Main unit memory heat conducting pad | 2 | |
| 12 | Main unit CPU heat conducting pad | 1 | |
| 13 | AC input to ACDC power cord | 1 | |
| 14 | Flat washer-Grade A GB/T97.1-2002 6 plated with green color zinc | 1 | |
| 15 | Grounding pillar | 1 | |
| 16 | Serrated lock washer external teeth GB/T862.2-1987 6 plated with green color zinc | 1 | |
| 17 | Stainless hex nut GB/T6170-2000 M6 passivated | 1 | |
| 18 | Conductive foam 2.0*7.0mm | 0.05m | 009-004993-00 |
| 13 | AC input to ACDC power cord | 1 | |

7.9 Battery Cavity Assembly

7.9.1 Exploded View

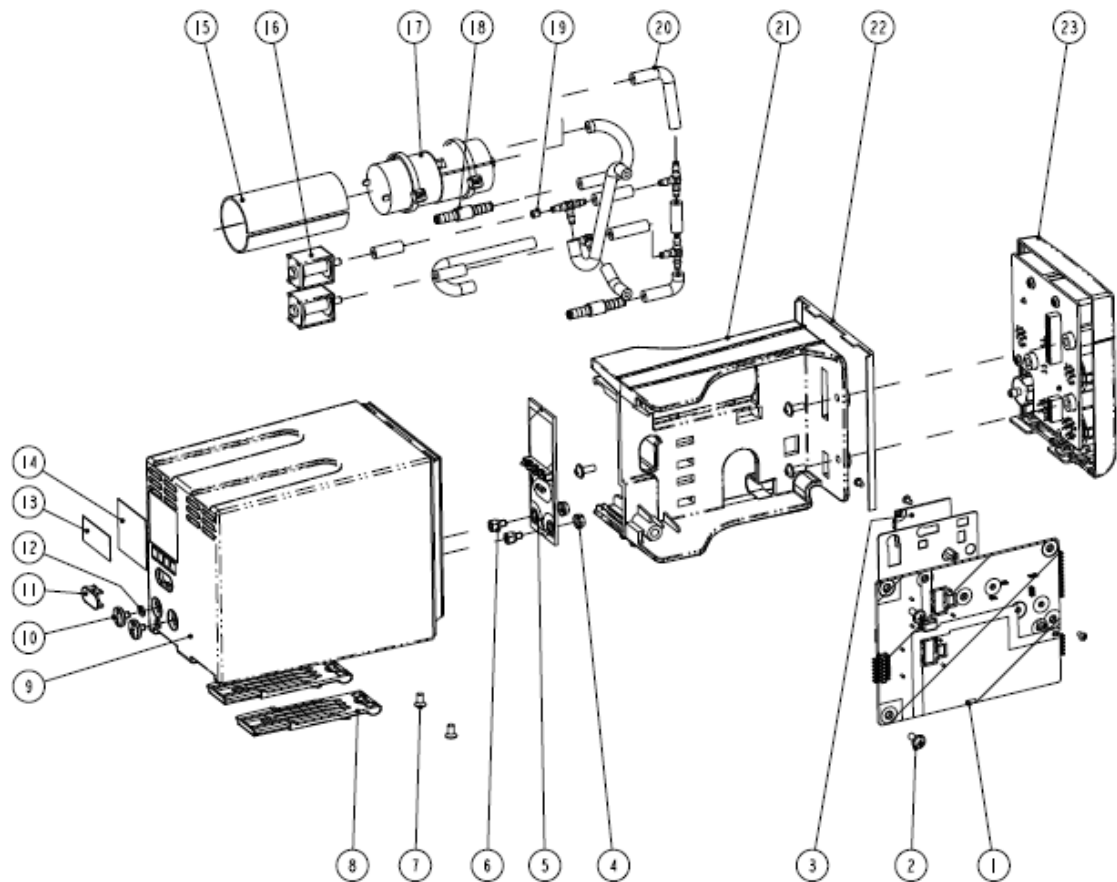


7.9.2 Parts List

| ITEM NO. | Description | Qty | FRU part number |
|----------|--|-----|-----------------|
| 1 | Battery cavity | 1 | 051-001932-00 |
| 2 | 6600 battery interface board PCBA | 1 | 043-005814-00 |
| 3 | Small cross recessed pan head GB9074.5-88 M3X6 with pad and plated with green color zinc | 2 | / |

7.10 M51C Module

7.10.1 Exploded View



7.10.2 Parts List

| ITEM No. | Name and Specification | Qty | Material Code |
|----------|--|-----|------------------|
| 1 | M51C-ME, 5L5P, MR/NC-SPO2, IBP, MPM I/F | 1 | 051-002482-01 |
| | M51C-ME, 5L5P, Masimo SpO2, IBP, MPM I/F | | 051-002492-01 |
| | M51C-FF (Ext Arr /12 Lead ST /Glasgow_12) | | 051-002483-00-00 |
| 2 | Stainless steel cross recessed pan head screw GB/T818-2000 M2X4 | 4 | / |
| 3 | Masimo SpO2 board | 1 | 040-003371-00 |
| | Nellcor SpO2 board | | 101-000469-00 |
| 4 | Hex nut and taper lock washer assembly M3 | 2 | M04-011002--- |
| 5 | M51C module back plane (with IBP/FRU) | 1 | 051-002383-00-00 |
| 6 | Fixing base | 2 | / |
| 7 | Cross recessed countersunk head screw GB/T819.1-2000 M3X6 | 2 | / |
| 8 | Spanner (T8) | 2 | / |

| ITEM No. | Name and Specification | Qty | Material Code |
|----------|--|-----|---------------|
| 9 | Dual module rear housing (M51C) | 1 | / |
| 10 | Terminal screw | 2 | / |
| 11 | Infrared lens | 1 | / |
| 12 | Standard spring washer GB/T93-1987 3 | 2 | / |
| 13 | Barcode serial number label 1 (for module) | 1 | / |
| 14 | High-end Mindray patent label (English) | 1 | / |
| 15 | Pump shock pad | 1 | / |
| 16 | Air valve. Dual air valve (custom) 12VDC normally-open line, 125 mm long | 2 | 082-000864-00 |
| 17 | Pump. 12VDC with 120 wire and connector | 1 | 082-000862-00 |
| 18 | Filter. Inline Filter43um 1/8" I.D. Tubing | 2 | / |
| 19 | 630F flow restrictor | 1 | / |
| 20 | Silicone tube | 11 | / |
| 21 | Bracket (T8) | 1 | 043-001964-02 |
| 22 | Module waterproof pad (M51C) | 1 | / |
| 23 | M51C front panel maintenance package (Masimo SpO2/IBP/analog FRU) | 1 | 115-057209-00 |
| | M51C front panel maintenance package (Nellcor SpO2/IBP/analog FRU) | | 115-044673-01 |
| | M51C front panel maintenance package (Nellcor SpO2/IBP FRU) | | 115-044671-01 |
| | M51C front panel maintenance package (Masimo SpO2/IBP FRU) | | 115-057562-00 |

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. Please 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

| 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 also. |
| | | 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 Labelling

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

- Main unit label
- Integrated warning labels

A.4 Scheduled Electrical Safety Inspection

For scheduled electrical safety inspection, perform all the test items listed in **A.6 Electrical Safety Inspection Test**.

A.5 Electrical Safety Inspection after Repair

The following table specifies test items to be performed after the equipment is repaired. Refer to **A.6 Electrical Safety Inspection for the description of the test items**.

| 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 |

A.6 Electrical Safety Inspection Test

| Inspection and Testing | | | Limit |
|------------------------|----------------------------------|-----------------------------|--|
| 1 | Power Cord Plug | | |
| 2 | Device Enclosure and Accessories | | / |
| 3 | Device Labeling | | / |
| 4 | Protective Earth Resistance | | Max 0.2 Ω |
| 5 | Earth Leakage | Normal condition(NC) | Max: NC: 300 μ A(refer to UL60601-1) |
| | | Single Fault condition(SFC) | SFC: 1000 μ A |
| 6 | Patient Leakage Current | Normal condition(NC) | Max: CF applied part: NC:10 μ A, SFC: 50 μ A |
| | | Single Fault condition(SFC) | BF applied part: NC:100 μ A, SFC: 500 μ A |
| 7 | Mains on Applied Part Leakage | | Max: CF applied part: 50 μ A BF applied part: 5000 μ A |
| 8 | Patient Auxiliary Current | Normal condition(NC) | Max: CF applied part: NC:10 μ A, SFC: 50 μ A BF applied part: NC:100 μ A, SFC: 500 μ A |

FOR YOUR NOTES

