BeneVision N17/BeneVision N15/ BeneVision N12

Patient Monitor

Service Manual

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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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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

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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.

2.1 Overview

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

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

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

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

2.2 Product System Architecture

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

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



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

2.2.1 Main Control Board

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



Figure 2-2 Diagram of the main control board

2.2.2 Internal Module Rack COM Board

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



2.2.3 Power Architecture

Figure 2-3 Diagram of power architecture

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

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

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

2.2.4 Independent Display Board (for the N17 Only)

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

2.2.5 iView Module (for the N17 Only)

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

2.2.6 Alarm LAMP Board

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

2.2.7 Power Switch Board

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

2.3 Data Logic Flow



Figure 2-4 Data flow diagram

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

3.1 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.
	Pressure check	
NIBP LESIS	Leakage test	1. If the user suspects that the measurement is incorrect.
Sidestream and Leakage test		2. Following any repair or replacement of relevant module.
Microstream CO ₂	Performance test	\neg 3. For NIBP module, at least once every two years; for CO ₂ and
tests	Calibration	 AG modules, once a year. A AG leakage test should be performed before AG
	Performance test	measurement.
AG tests	Calibration	
Performance Tests	1	
ECC to sta	Performance test	
ECG tests	Calibration	
Resp test		
SpO ₂ test		-
_	Pressure check	-
NIBP test	Leakage test	-
Temp test		
	Performance test	
IBP tests	Pressure calibration	1. If the user suspects that the measurement is incorrect.
C.O. test		2. Following any repair or replacement of relevant module.
Sidestream and	Leakage test	3. At least once every two years. For CO ₂ , AG and NMT
Microstream CO ₂	Performance test	modules, at least once a year.
tests	Calibration	4. AG leakage test should be performed before AG
	Leakage test	measurement.
AG tests	Performance test	
	Calibration	
EEG test		7
BIS test		7
	Interconnecting	7
CCO/SvO ₂ tests	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
Analog output performance test		not function properly.
Electrical Safety Tes	ts	
	Earth impedance	
Electrical safety tests	Earth leakage test	1. Following any repair or replacement of the power mode
	Patient leakage current	2. When the patient monitor is dropped.
	Patient auxiliary current	3. At least every two years or as required.
Other Tests		
Power on test		 When first installed or reinstalled. Following any maintenance or the replacement of any main unit parts.
Recorder check		Following any repair or replacement of the recorder.
Network print test		 When first installed. Whenever the printer is serviced or replaced.
Device integration check		 When first installed. Following any repair or replacement of the external device.
Battery check	Function test	 When first installed. Whenever a battery is replaced.
	Performance test	Once every two months or when the battery run time is reduced significantly.
Mounting check		 When first installed. At least every two years or as required.

Note: Performance test is not required for the rSO_2 , and $ScvO_2$ modules, because the rSO_2 , modules perform self tests, and the $ScvO_2$ needs to be calibrated prior to use.

3.1.3.1 Preventative Maintenance Procedures

3.1.4 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.

3.1.5 NIBP Tests 3.1.5.1 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.



- 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 **1.1.5.2 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.

3.1.5.2 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.

3.1.6 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 \rightarrow Maintenance \rightarrow enter the required password \rightarrow Module \rightarrow 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 CO_2 value is within 6±0.2% in the CO2 Maintenance menu (for microstream CO_2 , 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 O₂<80%) or $\pm 3\%$ (80% ≤O₂≤100%).

Calibration

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. 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 \rightarrow Maintenance \rightarrow enter the required password \rightarrow Module \rightarrow 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.

3.1.7 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.
- 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 $6\pm0.05\%$ CO**2**, 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: $a/c \le 0.01$ (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 ≥ 1.5%, CO2 ≥ 1.5%, N2O ≥ 40%, O2 ≥ 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 \rightarrow Maintenance \rightarrow enter the required password \rightarrow Module \rightarrow 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.



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

3.2 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.

3.3 Module Performance Tests

3.3.1 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 \rightarrow Filter \rightarrow Diagnostic.
- 2. Select **Main Menu** \rightarrow **Maintenance** \rightarrow enter the required password \rightarrow **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.

3.3.2 Resp Performance 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.

3.3.3 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% and100%.
- 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.

3.3.4 NIBP Tests

See section 3.1.5NIBP Tests.

3.3.5 Temp Test

Tools required:

- Resistance box (with accuracy above 0.1 Ω)
- 1. Connect the two pins of any Temp connector of a module to the two ends of the resistance box using two wires.
- 2. Set the resistance box to 1354.9 Ω (corresponding temperature is 37°C).
- 3. Verify each Temp channel of the monitor and make sure that the displayed value is within 37±0.1°C.
- 4. Repeat steps 1 to 3 to verify each Temp channel of the monitor.

3.3.6 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 \rightarrow Maintenance \rightarrow enter the required password \rightarrow Module \rightarrow 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.



Sphygmomanometer

- 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.

3.3.7 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±0.1°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.

3.3.8 Sidestream and Microstream CO₂ Tests

See section 3.1.6Sidestream and Microstream CO2 Tests.

3.3.9 AG Tests

See section 3.1.7AG Tests.

3.3.10 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

Connect the EEG module/cable to the EEG simulator and the monitor.

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



3.3.11 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 Convidien Signal simulator.

3.Set the time length of the review window to the shortest.

4.Verify the EMG value range from 65 to 75, and SQI value should be 100 displayed on Graphic Trends.

3.3.12 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.

3.3.13 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.
- 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 \rightarrow Maintenance \rightarrow enter the required password \rightarrow Module \rightarrow 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.

3.4 Nurse Call Relay Performance Test

Tools required: Multimeter

- 1. Connect the nurse call cable to the Nurse Call Connector of the patient monitor.
- 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.

3.5 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.

3.6 Electrical Safety Tests

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

NOTE

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

See Appendix A Electrical Safety Inspection for electrical safety tests.

3.7 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.

3.8 Network Print Test

NOTE

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

3.8.1 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 \rightarrow Maintenance \rightarrow enter the required password \rightarrow 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.

3.9 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.

3.10 Mounting Check

Tools required: None.

3.10.1 Safety check

Check the mounting of Patient Monitor is safe.

3.10.2 Overall Test and Check of Installed System

Implement installation test:

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

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

4.1 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 Repair and Disassembly*. Then, confirm that the monitor can operate normally and has passed all the performance tests. For the information about replaceable parts, refer to *Chapter 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 Troubleshooting Guide

Failure Symptom Possible Cause Countermeasure Power on failure AC Verify the AC mains is properly connected. mains not connected or Verify the battery capacity is sufficient and the insufficient battery batter is not damaged. power battery or damaged Cable defective Verify the cable connecting the power-on/off or improperly connected button board to the main control board. Verify the connecting cable connectors and corresponding sockets are not damaged. Power switch Replace the power switch and indicator board. and indicator board damaged Power module Replace the power module. defective Replace the main control board. Main control board failure

4.6.1 Power On/Off Failures

4.6.2 Display Failures

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

Failure Description	Possible Cause	Troubleshooting
SMR		
	External cable defective or poorly connected	 The cable connecting SMR and the main unit of the monitor is not connected properly or already damaged. Verify the connecting cables and connectors are not damaged. Verify that contact screws on SMR or module are tightly fastened and well connected.
	Defective parameter module	Replace the malfunctioning parameter module with a known good module. If the patient monitor identifies the replacement module and can start measurement, it indicates that the original module is faulty.
	Wrong communication board software version	Upgrade the module and/or the SMR software to a compatible level.
SMR cannot identify parameter modules	SMR power supply abnormal	 Check whether the SMR interface output voltage of the main unit is 12 V. If it is abnormal, the internal module rack COM board or main control board fails. Check whether the contact screw output voltage of the external module rack is 12 V. If it is abnormal, the communication module on the SMR fails.
	8-slot Module rack communication board defective	Replace 8-slot the module rack communication board.
	Internal module rack COM board defective	Replace the internal module rack COM board.
	Main control board failure	Replace the main control board.
Internal module rack		
The parameter module does not respond	Defective parameter module	Replace the malfunctioning parameter module with a known good module. If the patient monitor identifies the replacement module and can start measurement, it indicates that the original module is faulty.
	Cable defective from the main control board to the internal module rack COM board	 Verify the cable connecting the internal module rack COM board to the main control board is connected reliably. Verify the connecting cables and connectors are not damaged.

4.6.3 Module Rack Failures

Failure Description	Possible Cause	Troubleshooting
The parameter module does not respond	Logic version error of the internal module rack COM board	Upgrade the logic version of the internal module rack COM board.
	Power supply to the internal module rack is not correct	The internal module rack COM board or main control board may fail, and 12 V cannot be output.
	Main control board failure	Replace the main control board.

4.6.4 Alarm Failures

Failure Description	Possible Cause	Troubleshooting
Alarm LED off or cannot be turned off while the audible alarm is	Cable defective or improperly connected	 Verify the cable connecting the alarm LED board to the main control board is properly connected. Verify the connecting cables and connectors are not damaged.
sounding	Alarm LED board failure	Replace the alarm LED board.
	Main control board failure	Replace the main control board.
No audible alarm sounds emitted while the alarm	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.
LED is normal	Speaker failure	Replace the speaker.
	Cable defective or improperly connected	Verify the cable connecting the speaker to the main control board is properly connected.
	Main control board failure	Replace the main control board.

Failure Description	Possible Cause	Troubleshooting
	Internal module rack COM board defective	Replace the internal module rack COM board.
	Main control board defective	Replace the main control board.
No output for the nurse call signal	Cable defective or improperly connected	 Verify the cable connecting the main control board to the internal module rack COM board is connected reliably. Verify the connecting cables and connectors are not damaged.
	Logic exception of the internal module rack COM board	Upgrade the logic of the internal module rack COM board.
USB Device Unusable.	Main control board failure	Replace the main control board.
Network interface failure	Main control board failure	Replace the main control board.
DVI interface failure	Display not matched with the DVI interface time sequence	Use the recommended display.
	Main control board defective	Replace the main control board.
Touch screen failure of the external display	External display model not specified in the manual	Use the display model recommended in the user manual.
	Touch pad damage of the external display	Replace the display.
	Touch pad firmware of the external display inconsistent with the system software	Contact the display manufacturer to fix the problem.

4.6.5 Output Interface Failures

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

4.6.6 Power Supply Failures

4.6.7 Network Related Problems

Failure Description	Possible Cause	Troubleshooting
The patient monitor		
cannot be connected		
to iView system		
Frequent dropouts	Improper network cable connection	Check for network cable connection and length (which should not exceed 50 m), or check whether the laid network cable is too
		equipment.
	Incorrect network settings	Check for IP conflict in the network. If conflict is found, reset the network.
The patient monitor is connected to a network but cannot view other patients in the View Others mode	Improper network cable connection	Check for network cable connection and length (which should not exceed 50 m), or check whether the laid network cable is too near to the power supply for large power equipment.
	Too many simultaneous requests for viewing the patient monitor	Confirm the maximum number of simultaneously connected monitors according to the user manual.
	Incorrect network settings	Check for IP conflict in the network. If conflict is found, reset the network.

Failure Description	Possible Cause	Troubleshooting
	Incorrect network settings	Verify the wireless network settings are correct.
Failure to connect to a wireless network	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 failure	MPAN module damaged	Replace the MPAN module.
	MPAN module not connected to the internal module rack COM board properly	 Verify the cable connecting the MPAN module to the internal module rack COM board is connected properly. Verify the connecting cables and connectors are not damaged.
	Internal module rack COM board defective	Replace the module rack COM board.
	Wrong software version for the MPAN module	Upgrade the MPAN module software.

4.6.8 Device Integration Failures

Failure Description	Possible Cause	Troubleshooting
	The ID adapter is not compatible with the external device	 Replace the ID adapter. Upgrade the ID of the ID adapter in "Factory Maintenance" menu.
Integrated" window displays nothing after connection	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 The BeneLink module has no response when application software is corrupted	Upgrade or update the software application of the BeneLink module with the network upgrading tool.	
loading the D adapter	BeneLink module damaged	Replace the module.

4.6.9 Recorder Failures

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

FOR YOUR NOTES

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 re-installation. Do not drop, contaminate or lose them.

5.2 Optional Parameter Function Modules

You can install the following external 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 056529 00	MPM-14 module (Nellcor SpO2/12 lead ECG/IBP/Analog,	
	115-050558-00	FRU)	
	115-056539-00	MPM-15 module (Masimo SpO2/12 lead ECG/IBP/Analog	
	115 050559 00	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 CO2 module	
	115-056531-00	1-Slot CO2/O2 module	
AG module	115-056533-00	2-Slot AG/O2 module	
	115-056532-00	2-Slot AG/O2/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 SpO2 module	
	115-034088-00	Nellcor SpO2 module (package, no accessory)	
CCO/SvO ₂ module	115-013196-00	CCO/SvO ₂ module (Package, no accessory)	
ScvO2 module	115-013199-00	SCVO2 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	rSO₂module	
TEMP module	115-039492-00	Temp module (package, no accessory)	
Recorder module	115-053716-00	Recorder module	

You can insert and remove all the external modules during patient monitoring. Refer to the BeneVision N Series Patient Monitor Operator's Manual (P/N: 046-011259-00) for the use of parameter modules.

5.3 Optional Functional Assemblies

NOTE

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

Functional Assembly	PN	Name and Specification
CMD	115-033887-00	8-slot satellite module rack (SMR), with handle,
SIVIK		hook, and 2 m cable
Recorder	115-044523-00	Recorder upgrade package
Wi-Fi	115-044521-00	2.4G/5G Wifi upgrade package
MPAN	115-044522-00	MPAN upgrade package
iView	115-050002-00	iView upgrade package(Win 10)
Independent Display	115-044554-00	ID upgrade package (Without MainBoard)
2D barcode scanner	115-039575-00	2D Barcode scanner (USB) kit
	115-039635-00	2D Barcode scanner (support RFID) kit

Available functional upgrade options are:

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 (P/N: 046-011259-00).

5.3.2 Setting up Wireless Network Functions

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



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

5.3.3 Upgrading Recorder

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

5.3.4 Upgrading iView System

Refer to the corresponding section of this manual to install the related boards of the iView upgrade package in your patient monitor.

NOTE

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



5.3.5 Upgrading Independent Display Function

Refer to the corresponding section of this manual to install the related boards of the independent display upgrade package in your patient monitor.

NOTE

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



FOR YOUR NOTES

6.1 Tools

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

- Phillips screwdrivers
- Small flat-bladed screwdriver (specification 101 or 102)
- Contact spanner (6800-J95)
- Tweezers
- Needle nose pliers
- M3 sleeve

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 and take out all the batteries.
- Remove all the parameter modules in the integral module rack;
- if the SMR is connected, disconnect the SMR from the monitor and then remove all the parameter modules in it.

- 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 cables have been unplugged. During removal, note to avoid breaking the cable by pulling or damaging the connector.

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

6.3 Main Unit Disassembly

6.3.1 Basic Disassembly

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



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



(Screw covers)



(Screws)

6.3.2 Disconnecting the Base

NOTE

- When laying the monitor face down on, ensure the surface is static free and non-abrasive in order to avoid damaging the touch screen.
- Be sure to remove the base first before proceeding with other parts.
- 1. As shown in the figure below, place the monitor face up, unscrew the M4×8 screws (5 for the N12 series and 6 for the N15N17 series) from the bottom case;



(N15/N17)

- 2. Pull out the base.
 - For the N12 series machines, the base assembly can be removed when the base is pulled out.



• For the N15N17 series machines, the base assembly can be removed when the cable connected to the battery interface board of main board is pulled out.



NOTE

• Use caution when removing the Base so as not to damage the connectors and cables.

6.3.3 Separating the Front and Rear Half of the Monitor

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

NOTE

- When laying the monitor face down on, ensure the surface is static free and non-abrasive in order to avoid damaging the touch screen.
- Release the clip (if any) on the cable socket before disconnecting the cable. Be sure to pull out the base with proper force, without damaging the cables and connectors.
 - For the N12 series machines, remove the cable for the LCD screen and the cable for the small board of front case.



• For the N15N17 series machines, remove the cable for the touch screen, cable for the LCD screen and the cable for the small board of front case.



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

NOTE

- As shown in the following figure, there are two types of front case assemblies (NLT or SHARP). Cable connections differ between NLT and SHARP.
 - ♦ N12



(N12 rear case assembly)



(N12-NLT front case assembly)



(N12-SHARP front case assembly)

♦ N15



(N15 rear case assembly)



(N15-NLT front case assembly)



(N15-SHARP front case assembly)





(N17 rear case assembly)





(N17-NLT front case assembly)



(N17-SHARP front case assembly)

6.4 Further Disassembly of the Front Case Assembly

6.4.1 Removing the Power Switch Board

- 1. Remove the cable on the power switch board.
- 2. Remove the two PT3×8 screws and take out the power switch board.



NOTE

- Use care when disconnecting the cable to avoid damage. During installation, press the board to the silicone keypad direction by aligning with the front case board positioning rib.
- Use care to avoid overtightening the screws and stripping the holes when remounting the board.

6.4.2 Removing the Alarm Lamp and Light Sensor Board

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



NOTE

- Use care when disconnecting the cable to avoid damage.
- During installation, press the board to the alarm lamp shade direction by aligning with the front case board positioning rib.
- Use care to avoid overtightening the screws and stripping the holes when remounting the board.

6.4.3 Removing the Screen Assembly Cables

1. Cut the cable tie and disconnect the cables connected to the display screen and touch screen control board. All the cables can be removed by releasing the cable clamps on the front case.



(N12-NLT)

(N12-SHARP)





(N15-NLT)

(N15-SHARP)



(N17-NLT)

(N17-SHARP)

- Prevent pressure on the front face of display screen during disassembly.
- Remove the LCD screen assembly in an environment as dust-free as possible; the display screen and touch screen are integrated materials and cannot be disassembled.

6.5 Further Disassembly of the Rear Case Assembly

6.5.1 Removing the Recorder

- 1. First open the recorder door on the right of the machine, and then unscrew the two M3×6 screws.
- 2. Pull the two clips in as indicated in the figure below to separate it from the rear case, and pull out the recorder at the same time.
- 3. After the recorder is pulled out, remove the Recorder Cable from the Positioning Rib and disconnect the cable from the Recorder. The Recorder can now be removed.



NOTE

• Use care when disconnecting the cable to avoid damage.

6.5.2 Further Disassembly of the Recorder

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



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



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



Connector cable

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



NOTE

• Use care when disconnecting the cable to avoid damage.

6.5.3 Removing the Bluetooth Board

 Pull out the MPAN board cable at the end of internal module rack communication board; then pull out the MPAN antenna connector inserted on the Bluetooth board; unscrew one M3×6 screw to remove the MPAN board.



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



NOTE

• Use care when disconnecting the cable to avoid damage.

6.5.4 Removing the Wi-Fi Module

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



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



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



NOTE

- Use care when disconnecting the cable to avoid damage.
- Use care when removing the Wi-Fi Module from the Wi-Fi Support board to avoid damage to the connector. Provides application tips or other useful information to ensure that you maintain your product better.

6.5.5 Removing the Internal Module Rack Assembly NOTE

- Release the cable clips on the socket before attempting to disconnect the cable. Failure to do so will damage the cable.
- N12
- Disconnect the battery interface cable from the main board, then disconnect the internal module rack COMM board cable. Remove four M3x6 screws and lift up to remove the battery holder assembly.



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



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



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



- 5. Turn over the removed internal module rack COMM board, and remove the four POGO PIN silicon cases.



- N15N17
- 1. First remove the cable of internal module rack COMM board; unscrew the four M3X6 screws according to the positions shown below, and loosen one captive screw; force upward to remove the module rack assembly as indicated in the figure.



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



3. Turn over the removed internal module rack COMM board, and remove the six POGO PIN silicon cases.



6.5.6 Removing the Main Support Assembly (N12& N15)

- N12
- 1. Disconnect the Speaker cable, unscrew the two M3X6 screws, and remove the speaker assembly.



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


3. As shown in the figure below, after removing the main support assembly, place the main control board with face upwards. Remove the cable between the main control board and the ACDC power supply board., Unscrew the two DVI stud screws and four M3X6 screws, and then take out the main control board.



DVI stud screw

4. Turn over the main support assembly with the ACDC power supply board facing up. Disconnect the other end of the cable between the main board and the ACDC power supply board. Then disconnect the cable between the AC input to the ACDC power supply board. Unscrew four M3X6 screws, and remove the power board.



5. Loosen and remove two M3X6 screws and take out the recorder cover. Unscrew one M3X6 screw, and remove the cable from the AC input to ACDC power supply board.



- N15/N17
- 1. Disconnect the speaker cable. Loosen and remove the two M3X6 screws, and remove the speaker assembly.



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



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



3. As shown in the figure below, after removing the main support assembly, place the main control board with face upwards. Remove the cable between the main control board and the ACDC power supply board. Unscrew the two DVI stud screws and four M3X6 screws, and then take out the main control board.



4. Turn over the main support assembly with the ACDC power supply board facing up. Disconnect the other end of the cable between the main board and the ACDC power supply board. Then disconnect the cable between the AC input to the ACDC power supply board. Unscrew and remove the four M3X6 screws, and remove the power board.



5. Cut off the cable tie on the cable. Unscrew and remove the two M3X6 screws, and take out the recorder cover. Unscrew and remove one M3X6 screw, and remove the cable from the AC Input Connector to the ACDC Power Supply.



6.5.7 Removing the iView Board Assembly (N17)

1. First unscrew the two DVI stud screws.



 Remove the two iView board cable and the internal module rack cable. Loosen and remove the four M3X6 screws, and then take out the iView board assembly.



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



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



6.5.8 Removing the Independent Display Board Assembly (N17 Series)

1. First unscrew the two DVI stud screws.



2. Remove the independent display board cable and the internal module rack cable. Loosen and remove the four M3X6 screws, and then remove the independent display board assembly.



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



6.5.9 Removing the Handle

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



2. Pry the two handle pins towards the center of the case, then remove the handle.



6.6 Further Disassembly of the Base Assembly

N12

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



- N15/N17
- 1. Loosen and remove the two M3X6 screws, and remove the battery interface board.



2. As shown below, open the battery door, insert a pad between the battery door and the base and press down firmly to remove the battery door.



6.7 Disassembling the Module Rack

- 1. Removing the handle and hooks
 - As shown in the following figure, loosen and remove the eight M3X10 cross recessed screws, and remove the hooks.



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



2. Removing the rear case of module rack

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



3. Removing the module rack interface board

Loosen and remove the two M3X8 cross recessed pan head screws, disconnect the cable between the interface board and the internal module rack COMM board, and then remove the interface board.



4. Removing the internal module rack COMM board.

Disconnect the cable between the module rack antenna and the internal module rack COMM board. Loosen and remove the seven M3X8 cross recessed pan head screws on the internal module rack COMM board, and remove the eight POGO PIN silicon cases from the module rack.



6.8 Disassembling the MPM Module

- 1. Removing 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 removed.



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



2. Remove the parameter board

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



3. Removing the blood oxygen board

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



4. Removing the infrared board

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



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

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

7.1 N12 Parts



7.1.1.2 Parts List

ITEM No.	Description		FRU Part No.
1	N12-NLT front housing assembly (FRU)	1	115-044502-00
1	N12-Sharp front housing assembly (FRU)		115-044503-00
2	N12rear housing assembly (with TDS/BNC, with DVI)	1	/
3	N12 screw cover	/	049-001226-00
4	Cross recessed pan head screw, GB/T818-2000 M4X30	/	/
5	AC inlet hook	1	9211-20-87369

7.1.2 N12-NLT Front Housing Assembly

7.1.2.1 Exploded View



7.1.2.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N12-NLT front housing assembly (FRU)	1	115-044502-00
2	Screen clip	2	033-000636-00*
3	Light guild pillar	1	043-007582-00
4	MK hood	1	049-001214-00
5	MK alarm cap	1	049-001135-00
6	Alarm LED and Light Sensor Board PCBA	1	051-002693-00
7	Cross recessed pan head screws, PT3X8	4	/
8	N12 front shell plate cable	1	009-006396-00*
9	N12 Mainboard to LCD cable (NLT)	1	009-006410-00*
10	Power Switch and Indicate LED Board PCBA	1	051-002711-00

ITEM No.	Description	Qty	FRU Part No.
11	MK power button (P+R)	1	043-007956-01
12	Conductive cloth pad	0.08m	/
13	Earth plate (N12)	1	042-018667-00*
14	CORE O.D=21.5mml.D=9.5mm	1	/

*: included in No.1 N12-NLT front housing assembly (FRU) (115-044502-00).

7.1.3 N12-Sharp Front Housing Assembly

7.1.3.1 Exploded View



7.1.3.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N12-Sharp front housing assembly (FRU)	1	115-044503-00
2	Screen clip	2	033-000636-00*
3	Light guild pillar	1	043-007582-00
4	MK hood	1	049-001214-00

ITEM No.	Description	Qty	FRU Part No.
5	MK alarm cap	1	049-001135-00
6	Alarm LED and Light Sensor Board PCBA	1	051-002693-00
7	Cross recessed pan head screws PT3X8	4	/
8	N12 front shell plate cable	1	009-006396-00*
9	N12 Mainboard to LCD cable (NLT)	1	009-006409-00*
10	Power Switch and Indicate LED Board PCBA	1	051-002711-00
11	MK power button (P+R)	1	043-007956-01
12	Earth plate (N12)	1	042-018667-00*
13	Conductive cloth pad	0.08m	/
14	CORE O.D=21.5mmI.D=9.5mm	1	/

*: included in No.1 N12-Sharp front housing assembly (FRU) (115-044503-00)

7.1.4 N12 Rear Housing

7.1.4.1 Exploded View



7.1.4.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N12 handle	1	115 044501 00
2	Cushion pad	/	115-044501-00
3	N12 top cover	1	043-007578-01
4	Waterproof strip N12	1	048-006308-00
5	Handle Left Damping Block, N12	1	/
6	N12 rear housing (silk screen)	1	043-008005-01
7	N12 internal module rack assembly (with TDS/BNC)		/
8	Speaker bracket	1	115-044509-00
9	Speaker 2W 4ohm 500Hz	1	
10	MK speaker foam	1	
11	Cross recessed pan head screw, M3X6 with pad	/	/
12	N12 main bracket assembly (with DVI)	1	/
13	TR6F recorder	1	/
14	Handle Right Damping Block, N12	1	/
15	Self-Clinching Pilot Pins.TPS-3-18	/	/
16	Screw cap 2(T8)	/	049-000650-00
17	Cross recessed pan head crews,PT3X8	/	/
18	Conductive foam 2.0*7.0mm	/	/

7.1.5 N12 Rear Housing Assembly (FRU)(115-044499-00)

7.1.5.1 Exploded View



7.1.5.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N12 rear housing (silk screen)	1	043-008005-01
2	Handle Right Damping Block, N12	1	049-001250-00
3	Screw cap 2(T8)	3	/
4	Waterproof strip N12	1	048-006308-00
5	Handle Left Damping Block, N12	1	049-001249-00
6	Conductive foam 2.0*7.0 mm	0.11m	/

7.1.6 N12 Battery Cavity Assembly (FRU)(115-044504-00)

7.1.6.1 Exploded View



7.1.6.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N12 battery cavity	1	/
2	Cross recessed pan head screw GB/T818-2000 M4X30 plated with green color zinc	1	/
3	Battery bar	1	9211-20-87256
4	Battery bar sleeve	1	/
5	Cushion pad.Bumpon SJ5302, white and transparent	1	/

7.1.7 N12 Module Rack Body Assembly (FRU) (115-044507-00)

7.1.7.1 Exploded View



7.1.7.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N12 module rack (four slots)	1	/
2	Infrared lens	4	047-005213-00
3	Contact screw	8	6800-21-51100
4	Contact spring	8	6800-20-50261
5	Spring	8	6800-20-50388
6	Flat washer	8	/
7	Hex nut and taper lock washer assembly, M3	8	/

7.2.1 N15 Whole Unit

7.2.1.1 Exploded View



7.2.1.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N15-NLT front housing assembly (FRU)	1	115-044544-00
1	N15-Sharp front housing assembly (FRU)	1	115-044545-00
2	N15 rear housing assembly (with SMR/BNC)	1	/
3	N15 base assembly (FRU)	1	115-044543-00
4	Screw	/	/

7.2.2 N15-NLT Front Housing Assembly

7.2.2.1 Exploded View



7.2.2.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N15-NLT Front Housing Assembly	1	115 044544 00
I.	(FRU)	1	115-044544-00
2	Screen clip	4	033-000636-00*
3	Light guild pillar	1	043-007582-00
4	MK alarm cap	1	049-001135-00
5	MK hood	1	049-001214-00
6	Alarm LED and Light Sensor Board	1	051 002602 00
0	РСВА	1	051-002095-00
	Cross recessed pan head		
7	thread-cutting tapping screws	4	1
	PT3X8 plated with green color zinc		
8	N15N17 front shell plate cable	1	009-006736-00*
9	CORE O.D=21.5mml.D=9.5mm 1	1	1
10	N15 Mainboard to LCD cable (NLT)	1	009-006408-00*
11	N15N17 touch screen cable (NLT)	1	009-006397-00*
12	Power Switch and Indicate LED	1	051-002711-00

ITEM No.	Description	Qty	FRU Part No.
	Board PCBA		
13	MK power button (P+R)	1	043-007956-01
14	Conductive cloth pad	0.08m	/
15	Earth plate (NLT)	1	042-017398-00*

*: included in No.1 N15-NLT front housing assembly (FRU) (115-044544-00)

7.2.3 N15-Sharp Front Housing

7.2.3.1 Exploded View



7.2.3.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N15-Sharp front housing assembly (FRU)	1	115-044545-00
2	Screen clip	4	033-000636-00*
3	Light guild pillar	1	043-007582-00
4	MK alarm cap	1	049-001135-00
5	MK hood	1	049-001214-00

ITEM No.	Description	Qty	FRU Part No.
6	Alarm LED and Light Sensor Board PCBA	1	051-002693-00
7	Cross recessed pan head screws,PT3X8	4	/
8	N15N17 front shell plate cable	1	009-006736-00*
9	CORE O.D=21.5mml.D=9.5mm 1	1	/
10	N15 Mainboard to LCD cable (Sharp)	1	009-006407-00*
11	N15N17 touch screen cable (Sharp)	1	009-006730-00*
12	Power Switch and Indicate LED Board PCBA	1	051-002711-00
13	MK power button (P+R)	1	043-007956-01
14	Conductive cloth pad	0.08m	/
15	Earth plate (N15-Sharp)	1	042-018592-00*

*: included in No.1 N15-Sharp front housing assembly (FRU) (115-044545-00)

7.2.4 N15 Rear Housing

7.2.4.1 Exploded View



7.2.4.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N15 rear housing	1	043-008003-01
2	Handle left damping block, N15	1	/
3	N15 top cover	1	043-007566-01
4	N15 handle	1	
5	Cushion pad	1	115-044542-00
6	Blind rivet hole BSO-3.5M3-28 ZC	2	
7	Handle right damping block, N15	1	/
8	Cross recessed pan head thread-cutting tapping	/	/
	screws PT3X8 plated with green color zinc		
9	Recorder door	1	043-008499-00
10	MK speaker foam	1	115-044547-00
11	Speaker 2W 4ohm 500Hz	1	
12	Speaker bracket	1	
13	N 15 main bracket assembly (with DVI)	1	/
14	N15N17 module rack assembly (with SMR/BNC)	1	/
15	Screw	/	/
16	Conductive foam 2.0*7.0mm	/	/

7.2.5 N15 Rear Housing Assembly (FRU) (115-044541-00)

7.2.5.1 Exploded View



7.2.5.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N15 rear housing (silk screen)	1	043-008003-01
2	Waterproof foam (N15)	1	048-006291-00
3	N15 Handle Right Damp	1	049-001283-00
4	N15 Handle Left Damp	1	049-001284-00
5	Conductive foam 2.0*7.0 mm	3	/

7.2.6 N15 Base Assembly (FRU)(115-044543-00)

7.2.6.1 Exploded View



7.2.6.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N15 bottom case	1	1
2	N15 Battery Door (Tether)	1	043-007966-00
3	Rubber foot pad	4	/

7.2.7 N15N17 Module Rack Body Assembly (FRU) (115-044546-00)

7.2.7.1 Exploded View



7.2.7.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	Hex nut and taper lock washer assembly M3 plated	10	/
1	with green color zinc	12	
2	Flat washer-Grade A GB/T97.1-2002 3 plated with	12 /	
2	green color zinc	12	7
3	Spring	12	6800-20-50388
4	N15 module rack (six slots)	1	/
5	Infrared lens	12	047-005213-00
6	Contact screw	12	6800-21-51100
7	Contact spring	12	6800-20-50261
8	Captive screw M3X10	1	/

7.3 N17 Parts

7.3.1 N17 Whole Unit

7.3.1.1 Exploded View



7.3.1.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N17 front housing assembly	1	115-044551-00
1	N17-Sharp front housing assembly (FRU)	1	115-044552-00
2	N17 rear housing assembly	1	/
3	Screw	/	/
4	N17 screw cover	/	049-001210-00
5	N17 base assembly (FRU)	1	115-044550-00

7.3.2 N17-NLT Front Housing Assembly

7.3.2.1 Exploded View



7.3.2.2 Parts List

ITEM No.	Description	Qty	FRU Part No.	
1	N17-NLT front housing assembly	1	115-044551-00	
•	(FRU)	1		
2	Light guild pillar	1	043-007582-00	
3	MK alarm cap	1	049-001135-00	
4	MK hood	1	049-001214-00	
F	Alarm LED and Light Sensor Board	1	051 002602 00	
5	РСВА	1	031-002033-00	
6	Cross recessed pan head screws,PT	1		
0	3X8	4	7	
7	Screen clip	4	033-000636-00*	
8	N15N17 front shell plate cable	1	009-006736-00*	
9	CORE O.D=21.5mml.D=9.5mm 1	1	1	
10	N17 Mainboard to LCD cable (NLT)	1	009-006732-00*	
11	N15N17 touch screen cable (NLT)	1	009-006397-00*	
10	Power Switch and Indicate LED	1	051 002711 00	
12	Board PCBA	1	051-002/11-00	

ITEM No.	Description	Qty	FRU Part No.
13	MK power button (P+R)	1	043-007956-01
14	Conductive cloth pad	0.08m	/
15	Earth plate (NLT)	1	042-017398-00*

*: included in No.1 N17-NLT front housing assembly (FRU) (115-044551-00)

7.3.3 N17-Sharp Front Housing

7.3.3.1 Exploded View



7.3.3.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N17-Sharp front housing assembly (FRU)	1	115-044552-00
2	Light guild pillar	1	043-007582-00
3	MK alarm cap	1	049-001135-00
4	MK hood	1	049-001214-00
5	Alarm LED and Light Sensor Board PCBA	1	051-002693-00
6	Cross recessed pan head screws, PT	4	/

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ITEM No.	Description	Qty	FRU Part No.	
	3X8			
7	Screen clip	4	033-000636-00*	
8	N15N17 front shell plate cable	1	009-006736-00*	
9	CORE O.D=21.5mml.D=9.5mm 1	1	1	
10	N17 Mainboard to LCD cable		000 006208 00*	
10	(Sharp)	1	00-00200-00	
11	N15N17 touch screen cable	1	009-006730-00*	
11	(Sharp)	1		
12	Power Switch and Indicate LED	1	051-002711-00	
12	Board PCBA	1	051-002711-00	
13	MK power button (P+R)	1	043-007956-01	
14	Conductive cloth pad	0.08m	1	
15	Earth plate (N17-Sharp)	1	042-018593-00*	

*: included in No.1 N17-Sharp front housing assembly (FRU) (115-044552-00).

7.3.4 N17 Rear Housing

7.3.4.1 Exploded View



ITEM No.	Description	Qty	FRU Part No.		
1	N15N17 module rack assembly (with SMR/BNC)	1	/		
2	Small cross recessed pan head GB9074.5-88 M3X6	1			
2	with pad and plated with green color zinc	/	1		
2	N17 main bracket asembly (iView or independent	1			
5	display)		1		
4	Conductive foam 3.2*6.4mm	/	/		
5	Speaker bracket	1			
6	Speaker 2W 40hm	1	115-044547-00		
7	MK speaker foam	1			
8	Cross recessed pan head thread-cutting tapping	/	/		
	screws PT3X8 plated with green color zinc				
9	TR6F recorder	1	/		
10	AC inlet hook	1	9211-20-87369		
11	N17 rear housing (silk screen)	1	043-007458-01		
12	Waterproof foam (N17)	1	048-006292-00		
13	Handle right damping block, N17	1	/		
14	Blind rivet hole BSO-3.5M3-35 ZC	/	/		
15	Handle left damping block, N17	1	/		
16	N17 top cover	1	043-007661-01		
17	Cushion pad	2	115-044549-00		
18	N17 handle	1			

7.3.4.2 Parts List

7.3.5 N17 Rear Housing Assembly (FRU)(115-044548-00)

7.3.5.1 Exploded View



7.3.5.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N17 rear housing (silk screen)	1	043-007458-01
2	Conductive foam 3.2*6.4mm	0.11m	/
3	N17 Handle Left Damp	1	049-001285-00
4	Waterproof foam (N17)	1	048-006292-00
5	N17 Handle Right Damp	1	049-001286-00
7.3.6 N17 Base Assembly (FRU) (115-044550-00)

7.3.6.1 Exploded View



7.3.6.2 Parts List

ITEM No.	Description		FRU Part No.
1	N17 bottom case		/
2	Rubber foot pad	4	/
3	N15 Battery Door (Tether)	1	043-007966-00

7.3.7 Independent Display Upgrade Package (115-044554-00)

7.3.7.1 Exploded View



7.3.7.2 Parts List

ITEM No.	ITEM No. Description		FRU Part No.
1	Independent display assembly		115-044554-00
2	Small cross recessed pan head GB9074.5-88 M3X6 with	4	1
2	pad and plated with green color zinc	4	7

7.3.8 Independent Display Assembly

7.3.8.1 Exploded View



7.3.8.2 Parts List

ITEM No.	Description		FRU Part No.
1	N17 heat sink (iView or independent display)	1	041-026485-01
2	Independent Display Board PCBA	1	051-002712-00
3	Small cross recessed pan head GB9074.5-88 M3X6 with	A (
5	pad and plated with green color zinc	+	/

7.3.9 iView Module Assembly (115-050002-00)

7.3.9.1 Exploded View



7.3.9.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	N17 heat sink (iView or independent display)	1	041-026485-01
2	IVIEW CPU heat conducting pad	1	/
3	IVIEW memory heat conducting pad	4	/
4	Cross recessed pan head screw, M2X6	4	/

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ITEM No.	Description	Qty	FRU Part No.
5	Conductive foam 2.0*7.0mm	0.046m	/
6	Computer module Celeron J1900	1	023-001497-00
7	iView support board PCBA	1	051-003029-00
8	Small cross recessed pan head screws,	4	/
9	SSD 128GB MLC mSata	1	023-001329-00

7.4 External Satellite Module Rack (SMR)

7.4.1 Exploded View



7.4.2 Parts List

ITEM No.	Description	Qty	FRU Part No.
1	Front housing silkscreen of module rack	1	043-008617-00
2	8-slot PCBA of external module rack	1	115-054923-00
3	Interface board fixing sheet metal		/
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	1	1
/	plated with green color zinc	I	1
9	Module rack cable hook 1 1		115-033911-00

7.5 M51C Module

7.5.1 Exploded View



7.5.2 Parts List

ITEM No.	Name and Specification	Qty	Material Code	
	M51C-ME, 5L5P, MR/NC-SPO2, IBP, MPM I/F		051-002482-01	
1	M51C-ME, 5L5P, Masimo SpO2, IBP, MPM I/F	1	051-002492-01	
	M51C-FF (Ext Arr /12 Lead ST /Glasgow_12)		051-002483-00-00	
2	Stainless steel cross recessed pan head screw	4	1	
2	GB/T818-2000 M2X4	4		
2	Masimo SpO2 board	1	040-003371-00	
3	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	1	
7	Cross recessed countersunk head screw	2	1	
/	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)		115-057209-00
	M51C front panel maintenance package (Nellcor SpO2/IBP/analog FRU)	1	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

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.

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

A.1 Power Cord Plug

A.2 Device Enclosure and Accessories

A.2.1 Visual Inspection

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

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

A.2.2 Contextual Inspection

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 u	nit not disassembled	Test items: 1, 2, 3
Repair with main	When neither power supply PCBA nor	Test items: 1, 2, 3, 4
unit	patient electrically-connected PCBA is	
disassembled	repaired or replaced	
	When power supply PCBA is repaired	Test items: 1, 2, 3, 4, 5
	or replaced	
	When patient electrically-connected	Test items: 1, 2, 3, 4, 6, 7, 8
	PCBA is repaired or replaced	
	When both power supply PCBA and	Test items: 1, 2, 3, 4, 5, 6, 7, 8
	patient electrically- connected PCBA	
	are repaired or replaced	

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: 300µA(refer to UL60601-1)
		Single Fault condition(SFC)	SFC: 1000μA
6	Patient Leakage	Normal condition(NC)	Max:
	Current		CF applied part:
			ΝC:10μΑ, SFC: 50μΑ
		Single Fault condition(SFC)	BF applied part:
			NC:100μΑ, SFC: 500μΑ
7	Mains on Applied Part Leakage		Max:
			CF applied part: 50µA
			BF applied part: 5000μA
8	Patient Auxiliary	Normal condition(NC)	Max:
	Current		CF applied part:
			ΝC:10μΑ, SFC: 50μΑ
			BF applied part:
			NC:100μΑ, SFC: 500μΑ

A.6 Electrical Safety Inspection Test

FOR YOUR NOTES