

DPM 5 Patient Monitor

Operator's Manual

Revision History

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

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- Release time: 2015-03

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WARNING

- **Federal Law (USA) restricts this device to sale by or on the order of a physician.**
-

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Preface

Manual Purpose

This manual contains the instructions necessary to operate the product safely and in accordance with its function and intended use. Observance of this manual is a prerequisite for proper product performance and correct operation and ensures patient and operator safety.

This manual is based on the maximum configuration and therefore some contents may not apply to your product. If you have any question, please contact us.

This manual is an integral part of the product. It should always be kept close to the equipment so that it can be obtained conveniently when needed.

Intended Audience

This manual is geared for clinical professionals who are expected to have a working knowledge of medical procedures, practices and terminology as required for monitoring of critically ill patients.

Illustrations

All illustrations in this manual serve as examples only. They may not necessarily reflect the setup or data displayed on your patient monitor.

Conventions

- *Italic* text is used in this manual to quote the referenced chapters or sections.

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1 Safety

1.1 Safety Information

The safety statements presented in this chapter refer to the basic safety information that the operator of the patient monitor shall pay attention to and abide by. There are additional safety statements in other chapters or sections, which may be the same as or similar to the followings, or specific to the operations.

DANGER

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

WARNING

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

CAUTION

- Indicates a potential hazard or unsafe practice that, if not avoided, could result in minor personal injury or product/property damage.
-
-

NOTE

- Provides application tips or other useful information to ensure that you get the most from your product.
-
-

1.1.1 Dangers

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

1.1.2 Warnings

WARNING

- The device is intended for use by qualified clinical physicians or well-trained nurses in the specified places.
 - To ensure patient safety, verify the device and accessories can function safely and normally before use.
 - **EXPLOSION HAZARD:** Do not use this device in the presence of flammable anesthetics, explosive substances, vapors or liquids.
 - You must customize the alarm settings according to the individual patient situation, and make sure the alarm sound is activated when an alarm occurs.
 - **ELECTRIC SHOCK:** Do not open the monitor housing. All servicing and future upgrades to this device must be carried out by personnel trained and authorized by our company only.
 - **DEFIBRILLATION:** Do not come into contact with the patient during defibrillation. Otherwise serious injury or death could result.
 - When used in conjunction with electro-surgery equipment, you must give top priority to the patient safety. To prevent unwanted skin burns caused by leakage current, applying the electrode ,transducer and the cable as far as possible from the high frequency surgical equipment, a distance of least 15cm/6in. is recommended.
 - **DISPOSE:** Dispose of the package material, observing the applicable waste control regulations and keeping it out of children’s reach.
 - The device 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 the monitor from the power line and operate it on battery power, if possible.
 - The aging of the test equipment and the change of environment may have effects on the measuring results of the monitor.
-

1.1.3 Cautions

CAUTION

- To ensure patient safety, use only parts and accessories specified in this manual.
 - Remove the battery from the patient monitor if it will not be used or not be connected to the power line for a long period.
 - Disposable devices are intended for single use only. They should not be reused as performance could degrade or contamination could occur.
 - At the end of its service life, the product described in this manual, as well as its accessories, must be disposed of in compliance with the guidelines regulating the disposal of such products. If you have any questions concerning disposal of the products, please contact with us.
 - Magnetic and electrical fields are capable of interfering with the proper performance of the device. For this reason make sure that all external devices operated in the vicinity of the monitor comply with the relevant EMC requirements. Mobile phone, X-ray equipment or MRI devices are a possible source of interference as they may emit higher levels of electromagnetic radiation.
 - Before connecting the patient monitor to the power line, check that the voltage and frequency ratings of the power line are the same as those indicated on the label or in this manual.
 - Install or carry the patient monitor properly to avoid damages caused by drop, impact, strong vibration or other mechanical force.
-

1.1.4 Notes





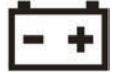








NOTE




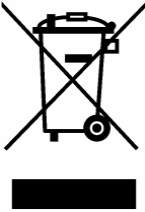
-
- **Keep this manual close to the patient monitor so that it can be obtained conveniently when necessary.**
 - **This patient monitor complies with the requirements of CISPR11 (EN55011) class A.**
 - **The software was developed per IEC601-1-4. The possibility of hazards arising from errors in software program is minimized.**
 - **Put the patient monitor in a location where you can easily see the screen and access the operating controls.**
 - **The instructions of this manual are based on the maximum configuration. Some of them may not apply to your patient monitor.**
-




1.2 Equipment Symbols

NOTE

- Some symbols may not appear on your equipment.
-

	Attention: Consult accompanying documents (this manual).
	Power ON/OFF
	Power ON/OFF
	Alternating current (AC)
	Battery indicator
	Type CF applied part. The unit displaying this symbol contains an F-type isolated (floating) patient part providing a high degree of protection against shock, and is suitable for use during defibrillation.
	TYPE BF applied part. Defibrillator-proof protection against electrical shock.
	Equipotentiality
	Auxiliary output
	Network connector
	VGA connector
	AG module connector
	Gas inlet

	ESD sensitivity
	Manufacture date
	Serial number
	<p>The following definition of the WEEE label applies to EU member states only.</p> <p>This symbol indicates that this product should not be treated as household waste. By ensuring that this product is disposed of correctly, you will help prevent bringing potential negative consequences to the environment and human health. For more detailed information with regard to returning and recycling this product, please consult the distributor from whom you purchased it.</p> <p>* For system products, this label may be attached to the main unit only.</p>

<p>The machine has only one of the certification labels below. Please refer to the label attached to the machine to determine the applicable certification label.</p>	
<p>ETL CLASSIFIED</p>  <p>Intertek 3191955</p>	<p>The presence of this label indicates the machine was certified by ETL with the statement:</p> <p>CONFORMS TO UL STD 60601-1, IEC 60601-2-27, IEC 60601-2-30, IEC 60601-2-34, IEC 60601-2-49, IEC60601-1-1, CERTIFIED TO CSA STD C22.2 NO 601.1, NO 60601-2-27, NO 60601-2-30, NO 60601-2-34, NO 60601-2-49, CSA STD C22.2 NO 601-1-1</p>
 <p>33SH E302540</p>  <p>UL60601-1 CAN/CSA-C22.2 No.601.1-M90</p>	<p>Classified by Underwriters Laboratories Inc. with respect to electric shock, fire and mechanical hazards, only in accordance with UL 60601-1, CAN/CSA C22.2 NO.601-1, IEC 60601-1-1, IEC 60601-2-27, IEC 60601-2-30, IEC 60601-2-34, IEC 60601-2-49.</p>

2 The Basics

2.1 Monitor Description

This monitor integrates the functions of parameter measurement, waveform monitoring, freezing, and recording, etc. Its color TFT liquid crystal display is able to show patient parameters and waveforms clearly. The monitor also features compact size, lightweight, easy-to-carry handle and built-in battery, which make it portable, especially in hospital transport. The compact control panel and control knob, and the easy-to-use menu system enable you to freeze, record, or perform other operations conveniently. Besides, this monitor can be connected with the central monitoring system whereby a monitoring network will be formed.

2.1.1 Intended Use

This monitor is intended to be used for monitoring, recording, and alarming of multiple physiological parameters (see **2.1.4 Functions**) on single adult, pediatric and neonate patient. For arrhythmia detection and ST Segment analysis, the target populations are adult and pediatric only.

This monitor is to be used in healthcare facilities by trained clinical physicians or appropriate medical staff under the direction of physicians. It is not intended for out-of-hospital transfer or home use.

WARNING

- **The operator of the monitor must be well trained. Any operation by unauthorized or non-trained personnel is forbidden.**
 - **The physiological waveforms and parameters and the alarm information displayed by the monitor are only for the reference of physicians, but cannot be used directly to determine the clinical treatment.**
-

2.1.2 Contraindications

None.

2.1.3 Components

This monitor consists of parameter measuring modules, blood pressure cuff, ECG, IBP cables, SpO₂ sensors, CO₂ and AG measuring components. Some of the components are optional and may not apply to your patient monitor.

2.1.4 Functions

This monitor is capable of monitoring the following parameters.

- ECG
 - ◆ Heart rate (HR)
 - ◆ ECG waveform(s)
 - ◆ ST segment analysis
 - ◆ Arrhythmia analysis
- RESP
 - ◆ Respiration rate (RR)
 - ◆ Respiration waveform
- SpO₂
 - ◆ Pulse oxygen saturation (SpO₂)
 - ◆ Pulse rate (PR)
 - ◆ SpO₂ plethysmogram
- NIBP
 - ◆ Systolic pressure (NS), diastolic pressure (ND), mean pressure (NM)
 - ◆ Pulse rate (PR)
- TEMP
 - ◆ Temperature of channel 1 (T1), temperature of channel 2 (T2)
 - ◆ Temperature differential between two channels (TD)
- IBP
 - ◆ 2 channels of IBP waveforms
 - ◆ Systolic (SYS), diastolic (DIA), and mean (MEAN) pressure
 - ◆ Pulse rate (PR).
- CO₂
 - ◆ End-tidal carbon dioxide (EtCO₂)
 - ◆ Fractional inspiratory carbon dioxide (FiCO₂)
 - ◆ Air-way Respiration Rate (AwRR)
- AG
 - ◆ Fraction of inspired carbon dioxide, nitrous oxide, oxygen or anesthetic gas (FiCO₂, FiN₂O, FiO₂, FiAA), and End-tidal carbon dioxide, nitrous oxide or oxygen (EtCO₂, EtN₂O, EtO₂, EtAA)
AA refers to one of the following anesthetic agents:
HAL (Halothane)
ISO (Isoflurane)
ENF (Enflurane)
SEV (Sevoflurane)
DES (esflurane)
 - ◆ Airway respiration rate (AwRR)
 - ◆ Minimum alveolar concentration (MAC)
 - ◆ 4 channels of AG waveforms (CO₂, N₂O, O₂ and AA)

2.2 External Appearance

2.2.1 Front Panel

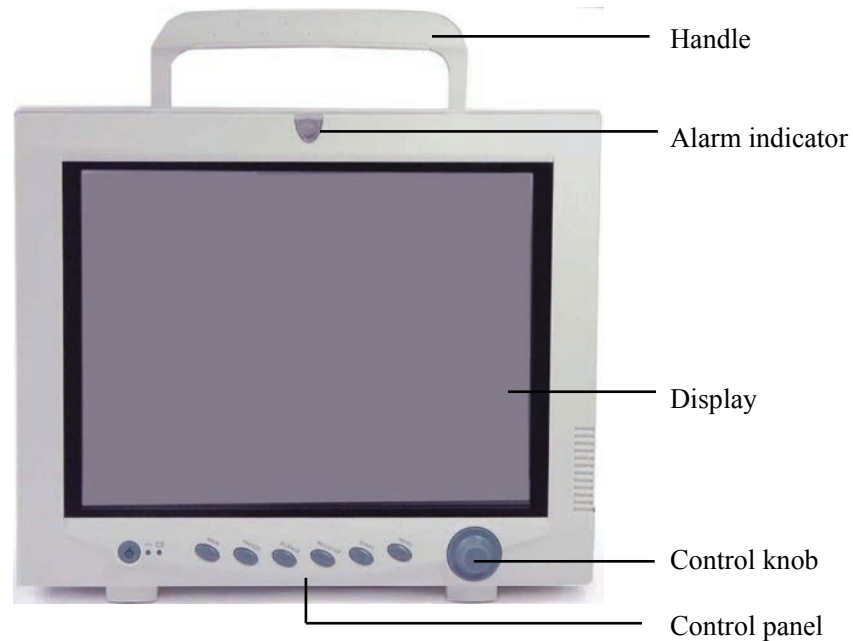


Figure 2-1 Front Panel

This monitor is designed to comply with the requirements of relative international safety standards (IEC60601-1, EN60601-2-27 and EN60601-2-30) for medical electrical equipment. This monitor has floating inputs and is protected against the effects of defibrillation and electrosurgery. When proper electrodes are used and applied according to the manufacturer instructions, the screen display will recover within 10 seconds after defibrillation.

The alarm indicator of this monitor complies with the requirement of EN60825-1 A11 Class 1 for LED. The LED indicator varies its flash color and frequency to indicate different alarm levels.

WARNING

- **Move or lift the monitor by the handle only. Do not use the patient cable or the power cord to move or lift the monitor. It might cause the monitor to fall, which might damage the monitor or injure the patient.**
-

2.2.2 Left Side Panel

Your monitor may not have all connectors as shown below.

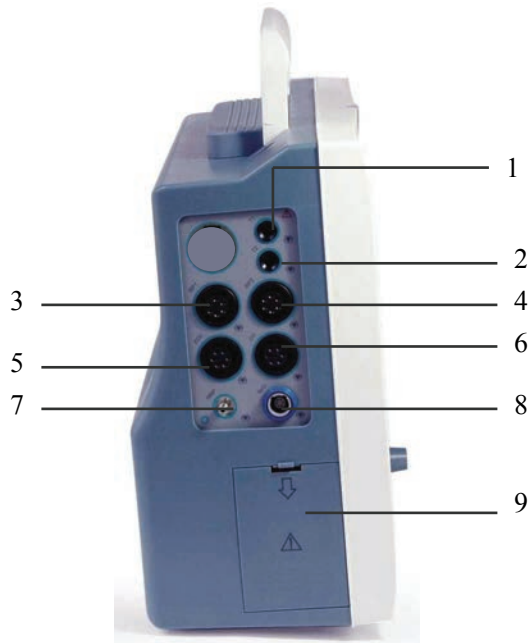


Figure 2-2 Left Side Panel

1. T1: Temperature probe connector (channel 1)
2. T2: Temperature probe connector (channel 2)
3. IBP1: IBP transducer connector (channel 1)
4. IBP2: IBP transducer connector (channel 2)
5. ECG: ECG cable connector
6. CO: CO cable connector (not available in USA)
7. NIBP: NIBP cuff hose connector
8. SpO2: SpO2 sensor connector
9. Battery door

2.2.3 Right Side Panel

The right side panel differs with different configurations as shown below.

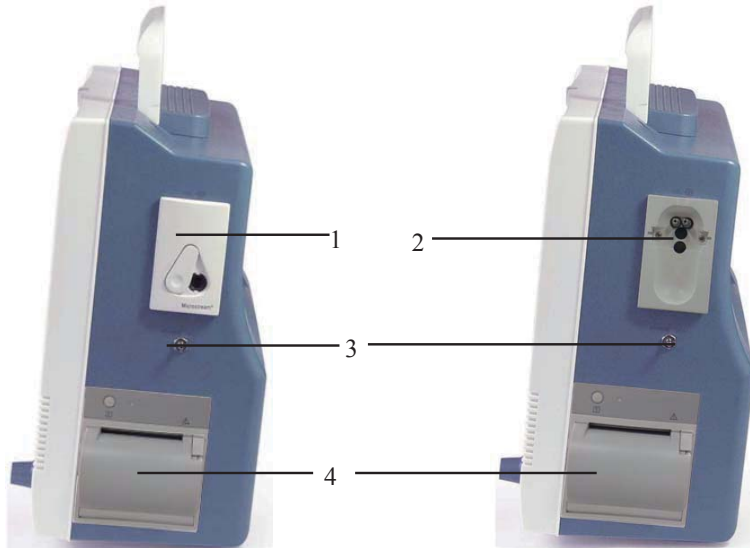


Figure 2-3 Right Side Panel

1. CO₂ sensor connector (Oridion CO₂ module)
2. Water trap connector (Mindray DS CO₂ or AG module)
3. Exhaust outlet
4. Recorder

NOTE

-
- Some modules are optional. Their connectors may not be available on your patient monitor.
 - If your monitor is equipped with CO₂ module, then it can't be equipped with AG module, vice versa.
-

2.2.4 Rear Panel

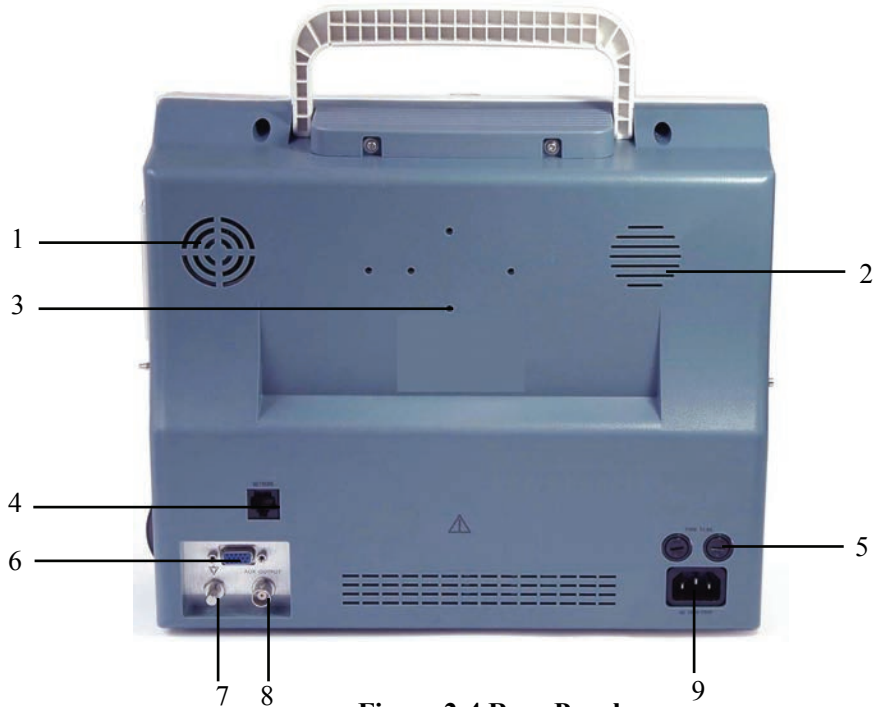


Figure 2-4 Rear Panel

1. Fan Vent
2. Speaker holes
3. Mounting holes for support bracket.
4. Network Connector: Standard RJ45 connector.
Through network connector, this monitor can be connected with the central monitoring system, another monitor, or a PC. It enables the functions of viewbed monitoring, data output and on-line software upgrading.
5. Fuse: Standard T3.0A
6. VGA Monitor Connector
A standard color VGA monitor can be connected to the patient monitor through this connector.
7. Equipotential grounding connector
8. Auxiliary Output Port: A standard BNC connector.
It is the common interface of analog output signals, nurse call output signals or defibrillator synchronization signals. You can manually select the function of this port in the USER MAINTAIN menu.
9. AC Power Input Connector
A three-wire power cord can be connected to this receptacle to provide AC power supply to the patient monitor.

⚠ WARNING

- **Accessory equipments connected to this patient monitor must be certified according to the respective IEC standards (e.g. IEC 60950 for information technology equipment and IEC 60601-1 for medical electrical equipment). Furthermore all configurations shall comply with the valid version of the system standard IEC 60601-1-1. Any person who connects additional equipment to the signal input or signal output is responsible to ensure the system complies with the requirements of the valid version of the system standard IEC 60601-1-1. If in doubt, contact our company or customer service.**
-

2.3 Control Panel

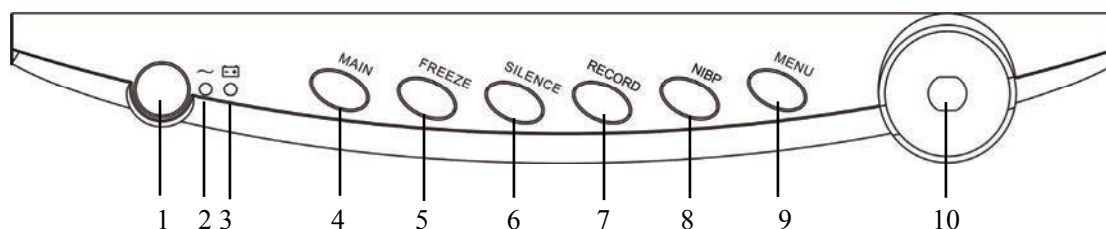


Figure 2-5 Control Panel

1. **Power switch**
This key turns the monitor ON and OFF. A built-in indicator is located inside this key, and it lights ON or OFF when the monitor is turned ON or OFF. To turn OFF the monitor, please press this key and hold for more than 2 seconds.
2. **AC power indicator**
 - ◆ ON: AC power is applied to the monitor.
 - ◆ OFF: AC power is not applied to the monitor.
3. **Battery indicator**
The battery indicator tells the battery status. See **2.5 Batteries** for more information.
4. **MAIN**
Press this key to exit the menu currently displayed, and return to the main screen.
5. **FREEZE**
This key is pressed to freeze and unfreeze waveforms.
6. **SILENCE**
You can press this key to pause alarms, silence the monitor or clear alarms. You can also switch between different alarm statuses through this key.
7. **RECORD**
Press this key to start or stop recording.
8. **NIBP**
Press this key to start or stop the non-invasive blood pressure measurement.
9. **MENU**
Press this key to display the SYSTEM MENU.

10. Control Knob

The main operator control is the control knob. The control knob rotates in either direction to highlight parameter labels and menu options. After highlighting the desired selection, press the control knob to execute an operation, make a selection, view a new menu or a small drop-down list. This procedure is referred to as “select ” through out the manual. Remember rotate to highlight, and then press to select.

2.4 Display

This monitor has a color TFT LCD display of high resolution. It is able to display patient parameters and waveforms clearly. The following is the standard interface when the monitor is operating normally.

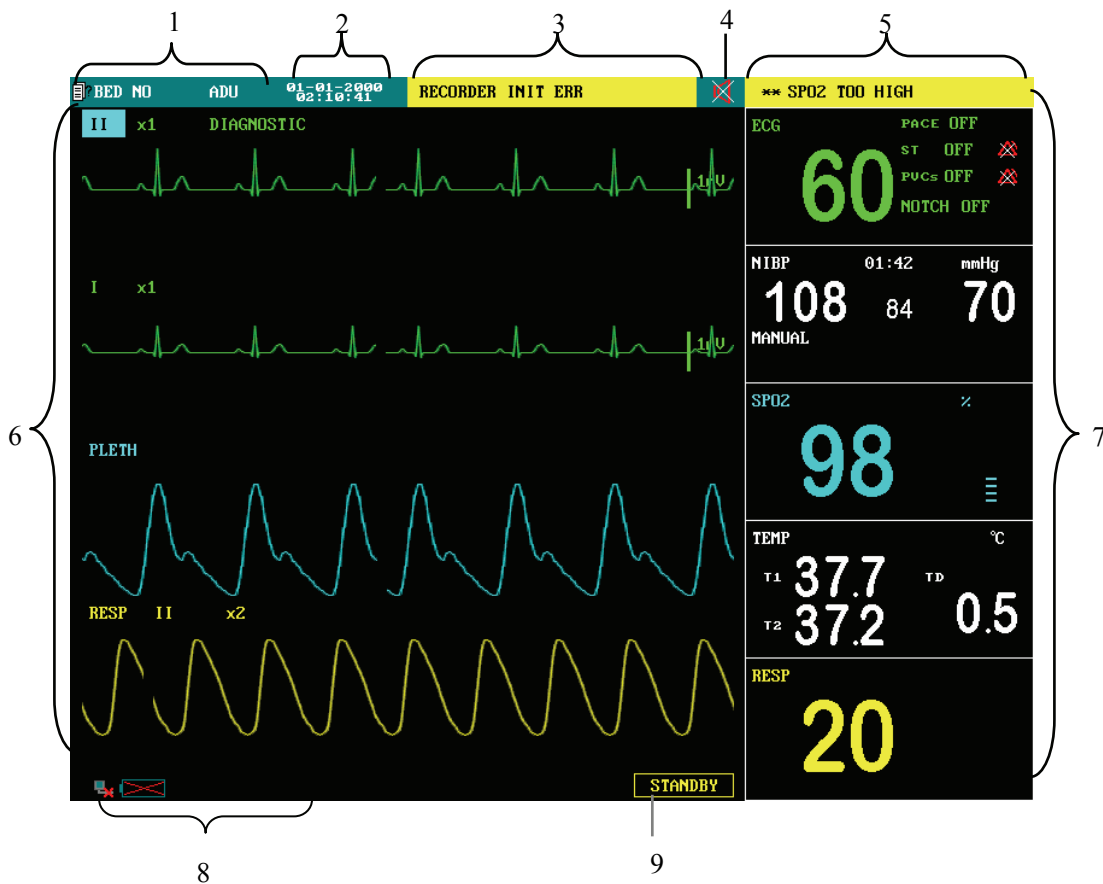


Figure 2-6 Main Screen

1. Patient information area

It displays patient bed number and patient type. If no patient is admitted, it displays “NO PATIENT ADMITTED”. If the patient’s information is incomplete, corresponding symbols will be displayed.




2. System time

The system time of the monitor is displayed in two lines. The time format can be set in the TIME SETUP menu.

3. Technical alarms area

Technical alarm messages or prompt information are displayed in this area. In case of multiple messages, they will be displayed alternately. This area shows the patient name and sex when no message is to be displayed.

4. Sound icon

 Alarms Paused;  System Silenced;  Alarm Sound Off. No icon is displayed under normal status.

5. Physiological alarms area

Physiological alarm messages are displayed in this area. In case of multiple messages, they will be displayed alternately.

6. Waveforms area

This area shows the waveforms of physiological parameters. The label of a waveform is displayed on the upper left.

7. Parameter windows

The parameter windows are located on the right of the waveform area, and are divided by white lines. Each window is identified by a parameter label on the upper left. You may select a parameter label to open the setup menu of this parameter. Each of the parameter is described in more detail in the following chapters.

8. Prompt information area

This area shows the prompt messages, network status icons, battery status icons, etc. Upon turning ON the monitor, prompt information, for example “NIBP alarm disabled”, will cover the network and battery icons.

9. STANDBY label

You may select this label to enter the standby mode.

2.5 Batteries



This monitor is designed to operate on battery (sealed lead-acid or Lithium Ion battery) power during intra-hospital patient transfer or whenever the power supply is interrupted. The battery is charged automatically when the monitor is connected to AC power, no matter the monitor is powered on or not. Whenever the AC power is interrupted during patient monitoring, the patient monitor will automatically run power from the internal batteries.

Sealed acid batteries and Lithium Ion batteries are differentiated by their contacts, as shown below.



Sealed lead-acid battery Lithium Ion battery Lithium Ion battery

The battery symbol displayed on the main screen tells the status of the battery.

-  The battery is installed in the battery slot.
The solid part indicates its capacity.
-  No battery is installed in the battery slot.

Besides, the battery indicator also indicates the status of the battery.


- ON: The battery is being charged or the battery is fully charged.
- OFF: No battery is installed. If the battery is installed but the monitor is not connected to AC power and not turned on, the indicator will also be off.
- Flashes: The monitor is powered by the internal battery.

The capacity of the internal battery is limited. When the battery capacity is too low, a high level alarm is triggered and the “Battery too low” message is given in the technical alarms area. At this moment, the AC power shall be applied to the monitor.

2.5.1 Battery Guidelines

Life expectancy of a battery depends on how frequent and how long it is used. For a properly maintained and stored lead-acid or lithium ion battery, its life expectancy is about 2 or 3 years respectively. For more aggressive use models, life expectancy can be less. We recommend replacing lead acid batteries every 2 years and lithium ion batteries every 3 years.

To get the most out of the battery, observe the following guidelines:

- The battery performance test must be performed every two years, before monitor repairs, or whenever the battery is suspected as being the source of the problems.
- Condition a battery once when it is used or stored for 3 months, or when its operating time becomes noticeably shorter.
- Take out the battery before the monitor is transported or will not be used for more than 3 months.
- Remove the battery from the monitor if it is not being used regularly. (Leaving the battery in a monitor that is not in regular use will shorten the life of the battery).
- The shelf-life of a fully charged sealed lead acid battery is about 6 months and in 6 months the battery must be fully charged for storage. The shelf life of a Lithium Ion battery is about 6 months when the battery is stored with the battery power being 50% (represented by the battery symbol ) of the total power. In 6 months the battery power must be depleted before the Lithium Ion battery is fully charged. Then run the monitor on this fully charged battery. When its battery power becomes 50% of the total power, take out the battery from the monitor and store it.

WARNING

- **Keep the battery out of the reach of children.**
 - **Use only the battery specified by the manufacturer.**
 - **If the battery shows signs of damage or signs of leakage, replace it immediately. Do not use a faulty battery in the monitor.**
-

2.5.2 Battery Maintenance

Conditioning a Battery

A battery should be conditioned before it is used for the first time. A battery conditioning cycle is one uninterrupted charge of the battery, followed by an uninterrupted battery discharge and charge. . Batteries should be conditioned regularly to maintain their useful life.

NOTE

-
- **Condition a battery once when it is used or stored for 3 months, or when its operating time becomes noticeably shorter.**
 - **The actual battery capacity will decrease over time with use of batteries. When a monitor operates on batteries that have been used before, the full capacity battery symbol does not indicate the capacity and operating time of this battery can still fulfill battery specifications in the operator's manual. When conditioning a battery, please replace the battery if its operating time is significantly lower than the specified time.**
-

To condition a battery, follow this procedure:

1. Disconnect the monitor from the patient and stop all monitoring or measuring.
2. Insert the battery in need of conditioning in the battery slot of the monitor, and leave the other slot empty if your monitor has two slots.
3. Apply AC power to the monitor and allow the battery to charge uninterrupted for 10 hours.
4. Remove AC power and allow the monitor to run from the battery until it shuts off.
5. Apply AC power again to the monitor and allow the battery to charge uninterrupted for 10 hours.
6. This battery is now conditioned and the monitor can be returned to service.

Checking a Battery

The battery performance test must be performed every two years, before monitor repairs, or whenever the battery is suspected as being the source of the problems. The performance of a rechargeable battery may deteriorate over time. To check the performance of a battery, follow this procedure:

1. Disconnect the monitor from the patient and stop all monitoring or measuring.
2. Apply AC power to the monitor and allow the battery to charge uninterrupted for 10 hours.
3. Remove AC power and allow the monitor to run from the battery until it shuts off.
4. The operating time of battery reflects its performance directly.

If your monitor has two battery slots, you can check two batteries at the same time. Please replace the battery or contact with the maintenance personnel if its operating time is significantly lower than the specified time.

NOTE

- **The battery might be damaged or malfunctioned if its operating time is too short after being fully charged. The operating time depends on the configuration and operation. For example, measuring NIBP more frequently will also shorten the operating time.**
 - **When a battery has visual signs of damage, or no longer holds a charge, it should be replaced. Remove the old battery from the monitor and recycle it properly.**
-

2.5.3 Battery Recycling

When a battery has visual signs of damage, or no longer holds a charge, it should be replaced. Remove the old battery from the monitor and recycle it properly. To dispose of the batteries, follow local laws for proper disposal.

WARNING

- **Do not disassemble batteries, or dispose of them in fire, or cause them to short circuit. They may ignite, explode, leak or heat up, causing personal injury.**
-

2.6 Wireless Network Card

This monitor can be configured with a wireless network card, which is connected to the CMS (Central Monitoring System) in the wireless mode and constructs with the CMS the monitoring network.

You only need to insert the network cable into the network connector. The following figure shows the wireless network card correctly installed.



In front of the wireless network card are three indicators that indicating its working status:

- POWER indicator
 - ◆ OFF: The wireless network card is off or the patient monitor is off.
 - ◆ Flashing: The wireless network card is resetting to the default.
 - ◆ ON: The wireless network card is on and ready.
- WIRELESS/WLAN indicator
 - ◆ OFF: The wireless network card is off or not associated with any access point.
 - ◆ Flashing: The wireless network card is associating or transmitting wireless data.
 - ◆ ON: The wireless network card is associated with an access point.
- ETHERNET/LAN indicator
 - ◆ OFF: The wireless network card is off or not connected to an Ethernet network.
 - ◆ ON: The wireless network card is connected to an Ethernet network.

The radio device used in the monitor is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC(Radio Equipment and Telecommunications Terminal Equipment Directive).

NOTE

-
- **The wireless network card is connected to the patient monitor via 5V power supply and a network port in the monitor. The 5V power supply is the only way for powering the wireless card, and the network port is used to get clinical data for wireless transmission. Please verify the connections before using the wireless network.**
 - **The design, installation, reconstruction and maintenance of the wireless network's distribution shall be performed by authorized service personnel of our company.**
 - **The existence of obstacles (such as wall) will exert impact on data transferring or even cause network interruption.**
 - **The Central Monitoring System is capable of connecting up to 16 bedside monitors via the wireless network.**
-

3 Installation

WARNING

- **The installation of the monitor must be carried out by personnel authorized by us. The software copyright of the monitor is solely owned by our company. Any action to change, copy or exchange the software copyright by any organization or person is regarded as copyright infringement and is not allowed.**
 - **Accessory equipments connected to this patient monitor must be certified according to the respective IEC standards (e.g. IEC 60950 for information technology equipment and IEC 60601-1 for medical electrical equipment). Furthermore all configurations shall comply with the valid version of the system standard IEC 60601-1-1. Any person who connects additional equipment to the signal input or signal output is responsible to ensure the system complies with the requirements of the valid version of the system standard IEC 60601-1-1. If in doubt, contact our company or customer service.**
 - **If the monitor is connected to another electrical instrument and the instrument specifications cannot tell whether the instrument combination is hazardous (e.g. due to summation of leakage currents), you should consult us or experts in the field to ensure the required safety of all instruments concerned.**
-
-

NOTE

- **The operations in this section are not all required. User-customized installation by authorized personnel is provided.**
-

3.1 Unpacking and Checking

Before unpacking, examine the packing case carefully for signs of damage. If any damage is detected, contact the carrier or our company.

If the packing case is intact, open the package and remove the instrument and accessories carefully. Check all materials against the packing list and check for any mechanical damage. Contact our Customer Service Department in case of any problem.

NOTE

-
- **Please save the packing case and packaging material for future transport and storage.**
-

WARNING

- **Be sure to keep the packaging materials from children's reach.**
 - **Disposal of the packaging materials shall comply with your local requirements.**
 - **The equipment might be contaminated in storage, transport or when used. Verify the package and the single use accessories are intact. In case of any damage, do not apply it to patients.**
-

3.2 Environmental Requirements

The operating environment of the monitor must meet the requirements specified in this manual.

The environment where this monitor is to be used should be free from noise, vibration, dust, and corrosive or explosive and inflammable substances. For a cabinet mounted installation, allow sufficient room at the front and the rear of the cabinet for operation, maintenance and servicing. Besides, allow at least 2 inches clearance around the instrument for proper air circulation.

Condensation can form when the monitor is moved from one location to another, and being exposed to differences in humidity or temperature. Make sure that during operation the instrument is free from condensation.

3.3 Power Source Requirements

The power applied to the monitor must meet the requirements specified in this manual.

WARNING

- **Make sure that the operating environment and the power applied to the patient monitor complies with the specified requirements. Otherwise its performance might not meet the specifications claimed in this manual, and unexpected results, such as damages to the patient monitor, may be incurred.**
 - **The monitor shall be powered according to the requirement for the system power voltage. Otherwise, serious damage might be caused to the system.**
-

3.4 Installation Method

3.4.1 Bracket Mounting

For details, please refer to the corresponding instructions for use of bracket mounting.

3.4.2 Connecting to AC Power Supply

1. Use the original three-wire AC power cord.
2. Connect the power cord to the receptacle for AC power cord on the rear panel of the monitor.
3. Connect the other end of the power cord to a compatible 3-prong hospital grade AC power outlet.

The 3-prong power outlet must be ground. If it is doubted, contact related personnel of the hospital.

WARNING

- **Do not use three-wire to two-wire adapter with this instrument.**
 - **To avoid unexpected power interruption, do not use power outlet with a wall-mounted switch control.**
-

3.4.3 Installing the Battery

If the monitor is to be powered by the internal battery, install the battery following the steps as below:

1. Open the door in the direction as marked on the battery door.
2. Move the battery catch above to one side using one finger.
3. Insert the battery into the battery slot per the “+” and “-” indications.
4. Move the battery catch to another side, and then insert the other one in the same way, if your monitor is equipped with two batteries.
5. Release the battery catch, and it will fix the battery.
6. Close the battery door.

WARNING

- **Make sure the battery door is securely latched. Falling batteries could seriously or fatally injure a patient.**
-

3.4.4 Connecting Patient Sensors and Probes

Connect the necessary patient sensors or probes to the monitor. For details, see the chapters for specific parameter monitoring in the following pages, or corresponding instructions for sensors and probes.

3.4.5 Connecting the Network Cable

The network connector of the monitor is a standard RJ45 connector. It connects the monitor with the central monitoring system, or with a PC for online upgrading or data output. It can also connect with another patient monitor for viewbed monitoring.

1. Connect one end of the network cable with the network connector of the monitor.
2. Connect the other end of the network cable with the hub or switch of the central monitoring system, or with the network connector of a PC, or with the network connector of another patient monitor.

NOTE

- **Different network cable may be used for different connections. Please consult our customer service personnel for details.**
 - **The system upgrading through the network connector is to be executed by our authorized personnel only.**
-

3.4.6 Auxiliary Output Port

The auxiliary output port can be used to generate analog signals, nurse call signals or defibrillator synchronization signals.

- Analog output signals can be generated when the monitor is connected to an oscilloscope or a pen recorder.
- If the monitor is connected with the Nurse Call System of a hospital through a special nurse call cable, the monitor can generate nurse call signals when alarms occur.
- If the monitor is connected with a defibrillation equipment, the monitor can generate defibrillator synchronization signals to the defibrillation equipment.

NOTE

-
- For detailed connection methods of different uses, please consult the specialist in your hospital, or our Customer Service.
 - The nurse call cable has two non-polarized conductors at the output end. The installation should be performed by our servicing engineers or engineers of the hospital according to the specific nurse call system of the hospital.
-

WARNING

- Before defibrillating the patient, the user should ensure the defibrillator and the monitor have been tested as a system and the two devices can work together safely and effectively.
-

3.4.7 Connecting to VGA Monitor

This monitor can be connected with a standard color VGA monitor. The VGA monitor will display the patient waveforms and parameters measured by the patient monitor. To connect the patient monitor with the VGA monitor, follow the steps as below.

1. Power off the patient monitor.
2. Connect the signal cable of the VGA monitor to the VGA connector on the rear panel of the patient monitor.
3. Power on the VGA monitor and then the patient monitor.

NOTE

-
- The VGA monitor should be installed at a distance of more than 1.5 m from the patient.
-

3.4.8 Equipotential Grounding

When other equipments are used together with the monitor, a grounding cable should be used to connect the equipotential grounding connectors of the monitor and of other equipments. This helps to reduce the potential differences between different pieces of equipment, and ensure the safety of the operator and patient.

WARNING

- **If the grounding system is in doubt, the monitor must be supplied from its internal battery.**
-

3.5 Powering on the Monitor

After installing the monitor, please follow the procedures described below to power on the monitor:

1. Before using the monitor, please carry out corresponding safety inspection as given in *17.1 Inspection*.
2. Press the Power Switch on the control panel. The alarm indicator will flash once in yellow and red. Then, a beep will be heard.
3. The system begins self-testing and the product model will be displayed on the screen.
4. Several seconds later, the system finishes the self-test and displays the main screen.
5. The system will initiate every module, and display “XX alarm disabled!” information in the lower left part of the screen. “XX” represents the name of every module, such as NIBP, RESP etc.
6. At this time, you can operate the monitor using the control panel. “XX alarm disabled!” information will disappear a few seconds later.

NOTE

-
- **During initialization process, alarms of every module detected by the system are useless, and thereby are disabled.**
-

3.6 Powering off the Monitor

To power off the monitor, please follow the procedures below:

1. Confirm the patient monitoring is to be finished.
2. Disconnect the cables and sensors between the monitor and the patient.
3. Confirm whether to store or clear the patient monitoring data.
4. Press the Power switch for more than 2 seconds, and the monitor will be powered off.

4 System Menu

4.1 Overview

This chapter only gives introduction to the system menu. Other menus will be described in the following chapters.

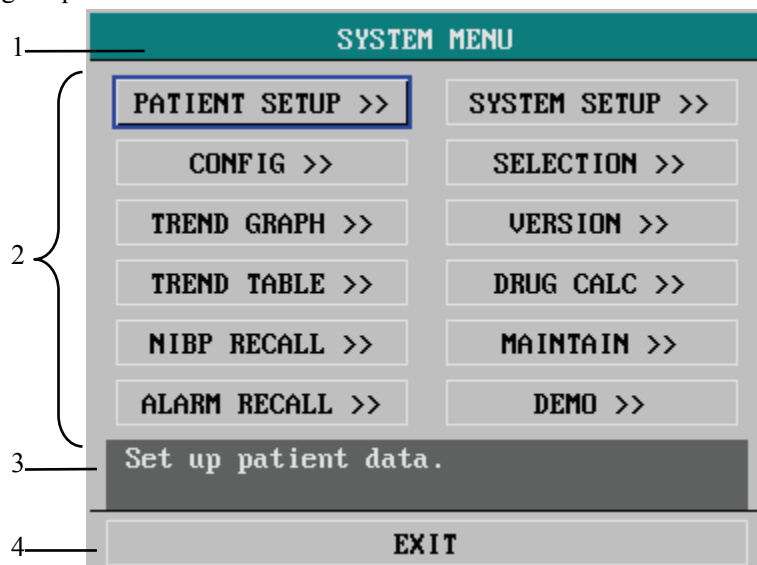


Figure 4-1 System Menu

Most menus displayed by the monitor share the same structure. As shown above, a menu is made up of four parts:

1. Menu title: Summarizes the content of the current menu.
2. Main display area: Displays options, keys or prompt information, etc. ">>" means a submenu will pop up if the option is selected.
3. Online help: The help information changes with the highlighted selection.
4. Exit key: Exits from the current menu.

Some menus do not have the EXIT key. Instead, a YES and a NO key or a CONFIRM and a CANCEL key are provided. You can confirm the operations with these keys.

NOTE

-
- Your monitor may not include all options described in this chapter.
-

4.2 Patient Setup

Select PATIENT SETUP>> in SYSTEM MENU. The following menu appears.

The screenshot shows a menu titled "PATIENT SETUP" with a teal header. Below the header, there are two columns of input fields and buttons. The left column contains: *PAT NO (text box), DOCTOR (text box), *NAME (text box), SEX (dropdown menu), PAT TYPE (dropdown menu with "ADU" selected), and PACE (dropdown menu with "OFF" selected). The right column contains: ADMIT (three spinners), BIRTH (three spinners), HEIGHT (spinner with "cm" dropdown), WEIGHT (spinner with "kg" dropdown), and BLOOD (dropdown menu). Below these fields are four buttons: "CLEAR PATIENT DATA" (highlighted with a blue border), "QUICK ADMIT PATIENT", "ADMIT PATIENT", and "MODIFY PATIENT". At the bottom, there is a dark grey bar with the text "Clear the current patient's data." and an "EXIT" button.

Figure 4-2 Patient Setup Menu

This menu displays the patient's information, as well as four buttons located below. If no patient is admitted, the buttons are:

- CLEAR PATIENT DATA
- QUICK ADMIT PATIENT
- ADMIT PATIENT
- MODIFY PATIENT

If a patient is admitted, the CLEAR PATIENT DATA button turns to be DISCHARGE PATIENT.

4.2.1 Admit Patient

To admit a new patient, please follow this procedure:

1. Select ADMIT PATIENT in PATIENT SETUP menu.
2. Select YES in the pop-up CONFIRM TO CLEAR THE DATA menu. The menu as shown below appears.

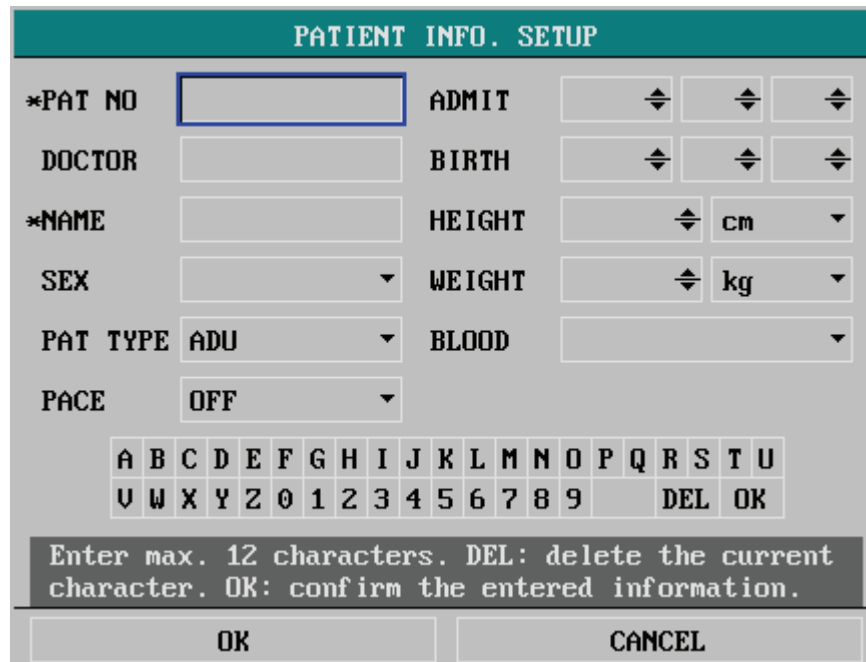



Figure 4-3 Patient Information Setup

3. Enter the patient's information details. If the patient's information is entered incompletely, corresponding symbols  will appear in the upper left hand of the monitor screen.

- PAT NO Patient identification number;
- DOCTOR Name of the doctor;
- NAME Patient name;
- SEX Patient gender: "F" for female; "M" for male;
- PAT TYPE Patient type:
ADU, PED and NEO (short for adult, pediatric and neonate);
- PACE Turn ON or OFF the pace analysis function;
- ADMIT The time when the patient is admitted: year-month-day;
- BIRTH Patient date of birth: year-month-day;
- HEIGHT Patient height (unit: cm or inch);
- WEIGHT Patient weight (unit: kg or lb);
- BLOOD Patient blood type:
A, B, O, AB or N (N represents unknown)

NOTE

- **If the PAT NO or NAME has not been input, “PATL. INFO. IMCMP” will be displayed in the patient information area.**
-

4. Select OK button, and the patient is admitted.
5. If the monitor is connected with the central monitoring system, you can monitor the patient through the central monitoring system.

Setting Patient Information

To enter information in a field containing no mark, follow this procedure (take PAT NO as an example):

1. Rotate the control knob and highlight the field after PAT NO.
2. Press the control knob, and the cursor jumps to the soft keypad below.
3. Rotate the control knob and move the cursor to the desired letter, number or space, and press the control knob to enter the character. Select DEL button to delete the unwanted entered character.
4. Repeat step 3 until you finish the information entering.
5. Select OK on the soft keypad. The information setting finishes.

To enter information in a field containing the mark “▼”, follow this procedure (take SEX as an example):

1. Rotate the control knob and highlight the field after SEX.
2. Press the control knob. A pop-up menu opens.
3. Rotate the control knob and select the desired option.

To set a feild containing the mark “◆”, follow this procedure (take HEIGHT as an example):

1. Rotate the control knob and highlight the field after HEIGHT.
2. Press the control knob.
3. Rotate the control knob and select the desired height. The height increases or decreases by one as the control knob rotates.

4.2.2 Quick Admit Patient

1. Select QUICK ADMIT PATIENT in PATIENT SETUP menu.
2. Select YES in the pop-up CONFIRM TO CLEAR THE DATA menu.
3. The following menu appears. You can set the PAT TYPE and status of PACE.

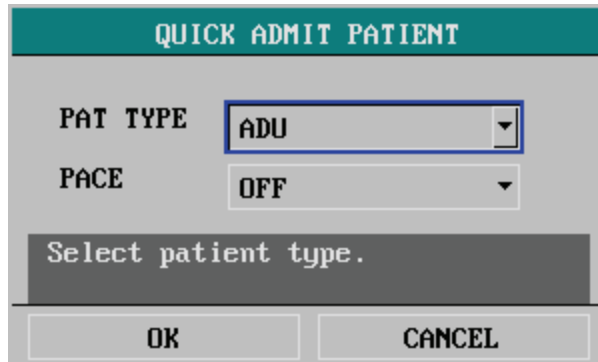


Figure 4-4 Quick Admit Patient

4. Select OK button, and the patient is admitted.
5. If the monitor is connected with the central monitoring system, you can monitor the patient through the central monitoring system.

4.2.3 Modify Patient

To modify the information of the patient being monitored, please follow this procedure:

1. Select MODIFY PATIENT button in PATIENT SETUP menu.
2. The menu as shown in *Figure 4-3* opens.
3. Modify the patient's information as described above, and select OK button.
4. Prompt information will be displayed on the central monitoring system if the monitor is connected with it.

4.2.4 Clear Patient Data

If a patient is monitored but not admit, before monitoring another patient, the data stored in the patient monitor should be cleared.

1. Click the CLEAR PATIENT DATA button in the PATIENT SETUP menu.
2. Select YES in the pop-up menu.

4.2.5 Discharge Patient

To discharge the patient being monitored, please follow this procedure:

1. Select DISCHARGE PATIENT in PATIENT SETUP menu.
2. Select YES in the pop-up menu.
3. Prompt information will be displayed on the central monitoring system if the monitor is connected with it.

4.3 Configuration Setup

Select CONFIG >> in the SYSTEM MENU. The following menu appears.

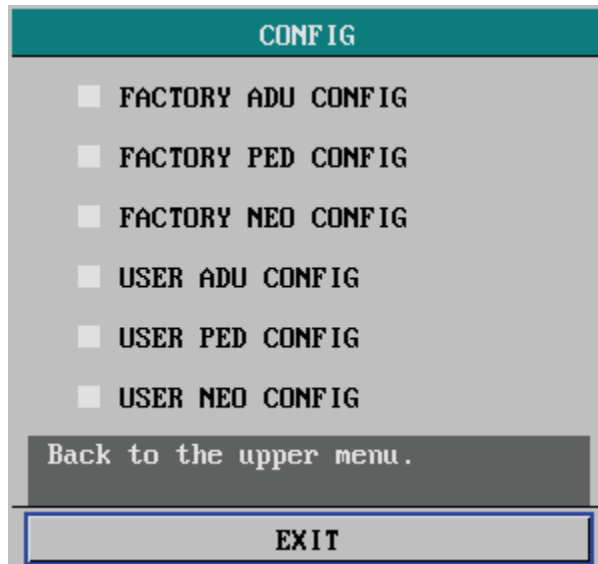


Figure 4-5 Configuration menu

If you have changed some settings during monitoring a patient and the changed settings are not proper, especially when a new patient is admitted, you can restore the factory configuration. According to the patient category, the monitor provides 3 kinds of factory configurations: factory adult configuration, factory pediatric configuration and factory neonatal configuration.

Restoring Factory Configuration

1. Rotate the control knob and select the desired configuration.
2. Select EXIT, and a CONFIRM CONFIG dialog box pops up.
3. Select YES to restore the monitor to the selected configuration, or select NO to cancel the operation.

4.4 System Setup

Select SYSTEM SETUP>> in SYSTEM MENU. The following menu appears.

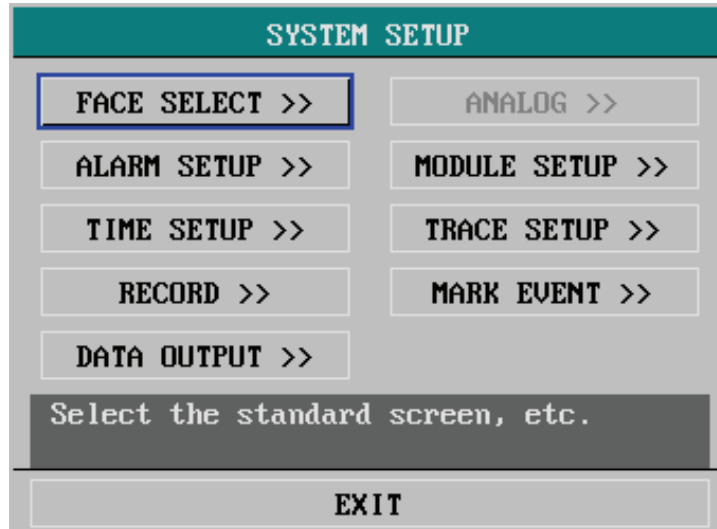


Figure 4-6 System Setup

SYSTEM SETUP menu contains the following submenus:

- FACE SELECT>>
- ALARM SETUP>>
- TIME SETUP>>
- RECORD>>
- DATA OUTPUT>>
- ANALOG>>
- MODULE SETUP>>
- TRACE SETUP>>
- MARK EVENT>>

4.4.1 Face Select

Select FACE SELECT>> in SYSTEM SETUP menu. The following menu appears.

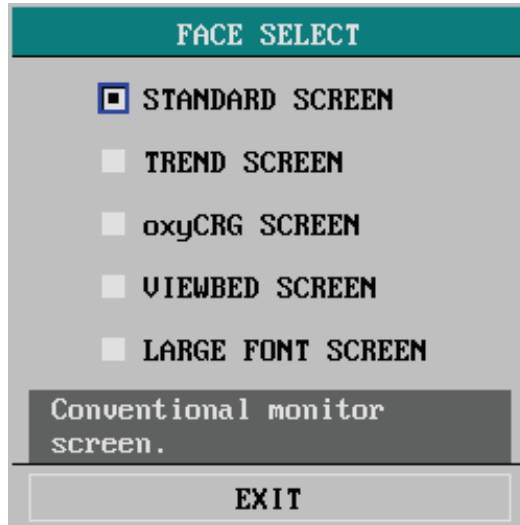


Figure 4-7 Face Select

In the FACE SELECT menu, options are available as shown above. For detailed information, see chapter *Face Selection*.

4.4.2 Alarm Setup

Select ALARM SETUP>> in SYSTEM SETUP menu. The following menu appears.

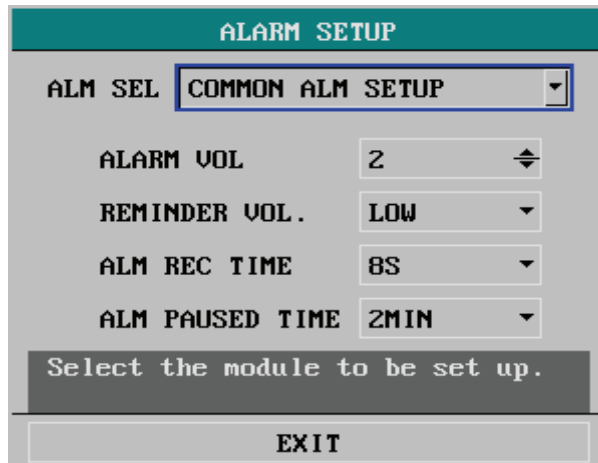


Figure 4-8 Alarm Setup

You can perform the following settings in the menu above:

- ALM SEL Alarm selection
Options: COMMON ALM SETUP, XX ALM SETUP;
(XX refers to physiological parameters such as HR,
SPO2, etc.).
If a parameter alarm setup is selected the corresponding
alarm setup items will be displayed in the ALARM
SETUP menu

- ALARM VOL Alarm volume
The volume can be set between 0 and 10. 0 means off
and 10 is the maximum volume.
The volume can not be set to 0 unless the ALARM
SOUND OFF is set to ENABLE (Refer to **4.7
Maintenance**). When the ALARM VOL is set to 0, it
will not be saved upon power failure. After the monitor
restarts, the ALARM VOL restores the default. It will
also restore its default if you silence or pause alarms.

- REMINDER VOL Options: HIGH, MED, LOW.

- ALM REC TIME Alarm recording time
Options: 8S,16S and 32S.
When an alarm occurs, the recorder records according
to the alarm recording time.

- ALM PAUSED TIME Options: 1MIN, 2MIN and 3MIN.

4.4.3 Time Setup

Select TIME SETUP>> in SYSTEM SETUP menu. The following menu appears.

The screenshot shows a menu titled "TIME SETUP" with a teal header. Below the header, there are seven rows of settings, each with a label on the left and a value in a box on the right. The "YEAR" field is highlighted with a blue border. Each row has a small up/down arrow icon to its right. At the bottom of the menu, there is a dark grey bar with the text "Set the system time." and a light grey bar with the text "EXIT".

TIME SETUP	
YEAR	2007
MONTH	6
DAY	8
HOUR	15
MINUTE	32
SECOND	44
FORMAT	MM-DD-YYYY
Set the system time.	
EXIT	

Figure 4-9 Time Setup

With the control knob, you can change the year, month, day, hour, minute and second as well as select the displayed format of the time. YYYY, MM, and DD refer to year, month and day respectively.

If the monitor is connected with the central monitoring system, the system time of the monitor will be updated in accordance with the central monitoring system, and the TIME SETUP option in SYSTEM SETUP menu will become disabled.

4.4.4 Recorder Setup

Select RECORD>> in SYSTEM SETUP menu. The following menu appears.

The screenshot shows a menu titled "RECORD" with the following options:

REC WAVE1	ECG1
REC WAVE2	ECG2
REC WAVE3	OFF
RT REC TIME	8S
TIMING REC TIME	OFF
REC RATE	25.0
REC GRID	ON

Below the options is a button labeled "CLEAR REC TASK". At the bottom, there is a dark grey box containing the text "Set the first real-time recorded waveform." and a button labeled "EXIT".

Figure 4-10 Recorder Setup

In this menu, you can adjust the following items:

- REC WAVE1 Select the first waveform to be recorded. The setting of this item should be different with those of REC WAVE 2 and REC WAVE3; otherwise, the system will adjust the setting automatically. When OFF is selected, the first waveform will not be recorded.
- REC WAVE2 Select the second waveform to be recorded. The setting of this item should be different with those of REC WAVE1 and REC WAVE3; otherwise, the system will adjust the setting automatically. When OFF is selected, the second waveform will not be recorded.
- REC WAVE3 Select the third waveform to be recorded. The setting of this item should be different with those of REC WAVE1 and REC WAVE2; otherwise, the system will adjust the setting automatically. When OFF is selected, the third waveform will not be recorded.

NOTE

-
- If a parameter is not displayed on the screen, this parameter will not be an option of REC WAVE 1, REC WAVE 2 and RECORD WAVE3..
-

- RT REC TIME Real-time recording time
Options: CONTINUAL and 8s.
- TIMING REC TIME Timing recording time
The interval between automatic recordings.
Options: OFF, 10MIN, 20MIN, 30MIN, 40MIN, 50MIN, 1HOUR, 2HOURS, 3HOURS and 4HOURS. The monitor will start recording at the selected interval, record for 8s and stop automatically.

NOTE

- **TIMING REC TIME cannot be saved after the monitor is turned off. But it can be saved as the user default configuration.**
- **RT REC TIME has priority over TIMING REC TIME.**

- REC RATE Recording rate
Options: 25.0 and 50.0; unit: mm/s;
- REC GRID Recording grid
ON: You can select ON to print a grid on the recorder paper;
OFF: You can select OFF to print without grid on the recorder paper.
- CLEAR REC TASK Clear recording task
This key allows you to clear all current recording tasks.

4.4.5 Data Output

Select DATA OUTPUT>> in SYSTEM SETUP menu. The following menu appears.

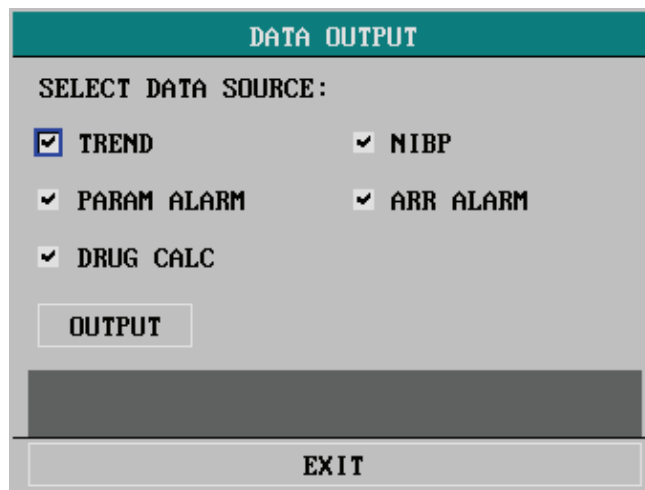


Figure 4-11 Data Output

Output Procedure

1. Disconnect all patient cables connected to the monitor.
2. Verify the monitor is connected to the PC and the PC is running the Patient Information Recall System software.
3. Select from the data source options.
4. Select OUTPUT in the menu and the prompt “CONNECTING...” is shown aside. If you exit the DATA OUTPUT menu at this time, the prompt will be displayed in prompt information area at the lower left corner of the screen.
5. If the connection is available, the data will be output to the PC. For more information, please refer to the help information of the Patient Information Recall System software.

NOTE

-
- **If no data source is selected or the previous data output has not finished, the OUTPUT option in the DATA OUTPUT menu will be inactive.**
-

4.4.6 Analog Output

Select ANALOG >> in SYSTEM SETUP menu. The following menu appears.

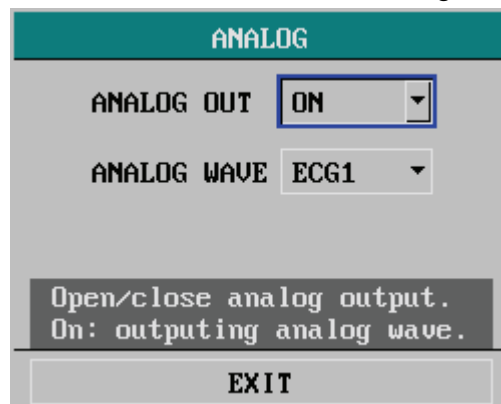


Figure 4-12 Analog Output

You can perform the following settings in the menu above:

- **ANALOG OUT** Analog output
Options: ON and OFF.
When ON is selected, analog signals can be output from the auxiliary output port on the rear panel of the monitor.
- **ANALOG WAVE** Options: ECG1, ECG2, IBP1 and IBP2;
In the MULTI-LEADS DISPLAY mode, the ECG3, ECG4, ECG5 and ECG6 options are also available.

NOTE

- If DEFIB. SYN or NURSE CALL is selected from the AUX OUTPTU options in the USER MAINTAIN menu, the ANALOG>> option in the SYSTEM SETUP menu will be inactive, and the monitor will be unable to output analog signals. For details, please refer to 4.7 Maintenance.
-

4.4.7 Module Setup

Select MODULE SETUP>> in SYSTEM SETUP menu. The following menu appears.

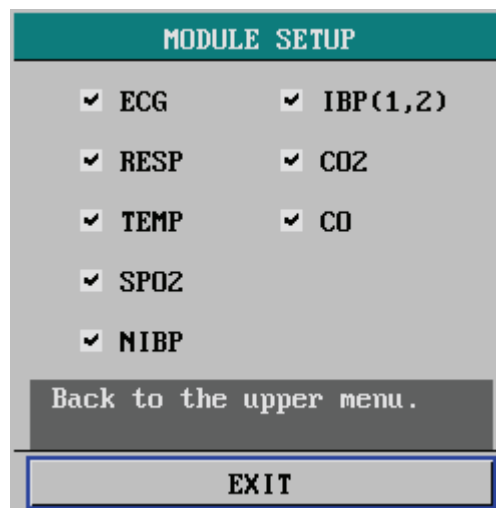
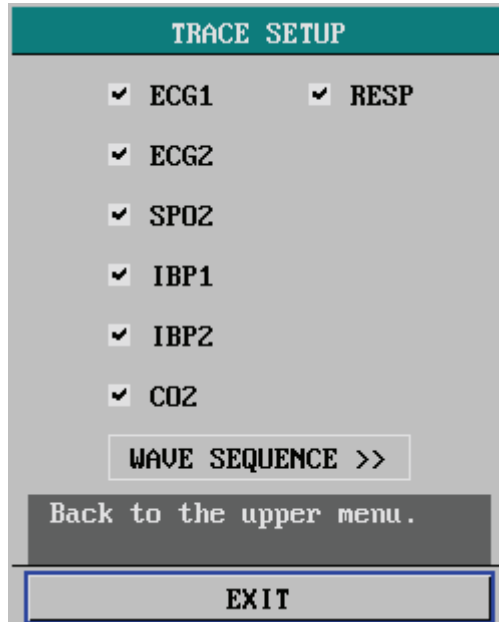


Figure 4-13 Module Setup

This menu allows you to enable or disable a parameter module to determine the information displayed on the main screen. As shown in the figure above, “√” indicates an enabled module. A module without the “√” mark is disabled and the related waveform and parameter data disappear from the display.

4.4.8 Trace Setup

Select TRACE SETUP>> in SYSTEM SETUP menu. The following menu appears.



TRACE SETUP

ECG1 RESP

ECG2

SPO2

IBP1

IBP2

CO2

WAVE SEQUENCE >>

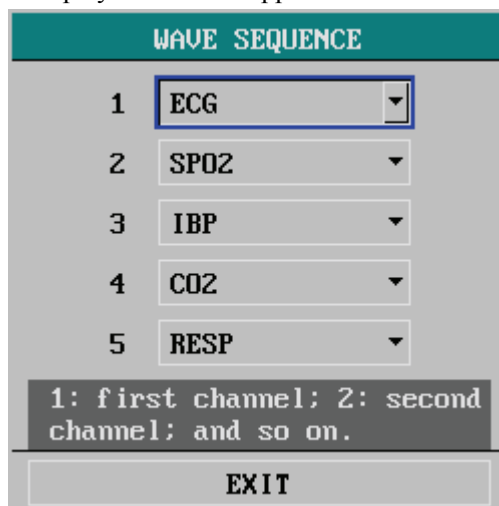
Back to the upper menu.

EXIT

Figure 4-14 Trace Setup

This menu allows you to select the parameter waveform(s) to be displayed. The mark “√” indicates the parameter waveform will be displayed, and that without the mark will not be displayed. The TRACE SETUP menu merely contains the parameter modules enabled in the MODULE SETUP menu. Besides, in the MULTI-LEADS DISPLAY mode or the HALF-SCREEN MULTI-LEADS display mode, the ECG1 waveform and the ECG2 waveform are inactive.

In addition, the WAVE SEQUENCE >> option allows you choose in which sequence the parameter waveforms are displayed from the upper to the lower.



WAVE SEQUENCE

1 ECG

2 SPO2

3 IBP

4 CO2

5 RESP

1: first channel; 2: second channel; and so on.

EXIT

Figure 4-15 Wave Sequence

4.4.9 Mark Event

Select MARK EVENT>> in SYSTEM SETUP menu. The following menu appears.

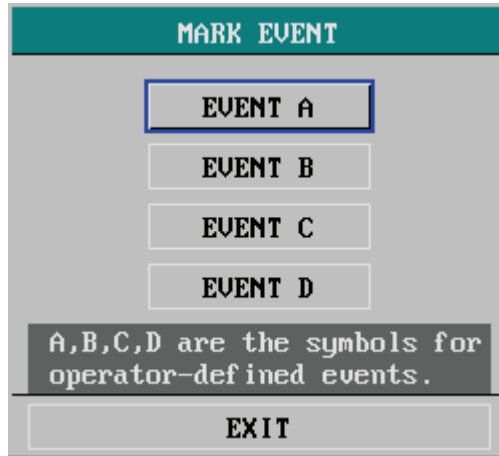


Figure 4-16 Mark Event

This menu allows you to mark four different events, namely event A, B, C and D. The “@” symbol will appear in the frame of the event being selected. If you attempt to unmark an event, press the control knob again on the marked selection.

The purpose of event marking is to define the records, such as dose taking, injections or therapy, which have influence on patients and parameter monitoring. A mark will be displayed on the trend graph/table indicating the time the mark was initiated in relation to the event it represents.

4.5 Selection Setup

Select SELECTION>> in SYSTEM MENU. The following menu appears.



Figure 4-17 Selection Setup

You can perform the following settings in this menu:

- **KEY VOL** Key volume
The volume can be set between 0 and 10. 0 indicates the volume is off and 10 indicates the maximum volume.
- **HELP** Online help
ON: Indicates the online help is enabled and the help information will be displayed;
OFF: Indicates the online help function is disabled and the help information will not be displayed.
- **SCAN TYPE** Scan type
REFRESH: The waveform keeps stationary, with real-time refreshing from the left to the right by a moving "erase bar";
SCROLL: The waveform moves from the right to the left with time passing by.
- **ALM LIMIT** Alarm limit
ON: The alarm limits of parameters are displayed aside the parameter value;
OFF: The alarm limits of parameters are not displayed aside.
- **BRIGHTNESS** The brightness can be set between 1 and 10. 1 indicates the lowest brightness and 10 indicates the highest brightness.

4.6 Monitor Version

You can select VERSION>> in the SYSTEM MENU to check the version information as shown below.. However, the VERSION menu of you monitor may be different.



Figure 4-18 Version

You can see the monitor's configuration by selecting DEVICE CONFIG LIST>> as shown below. However, the DEVICE CONFIG LIST menu of you monitor may be different.

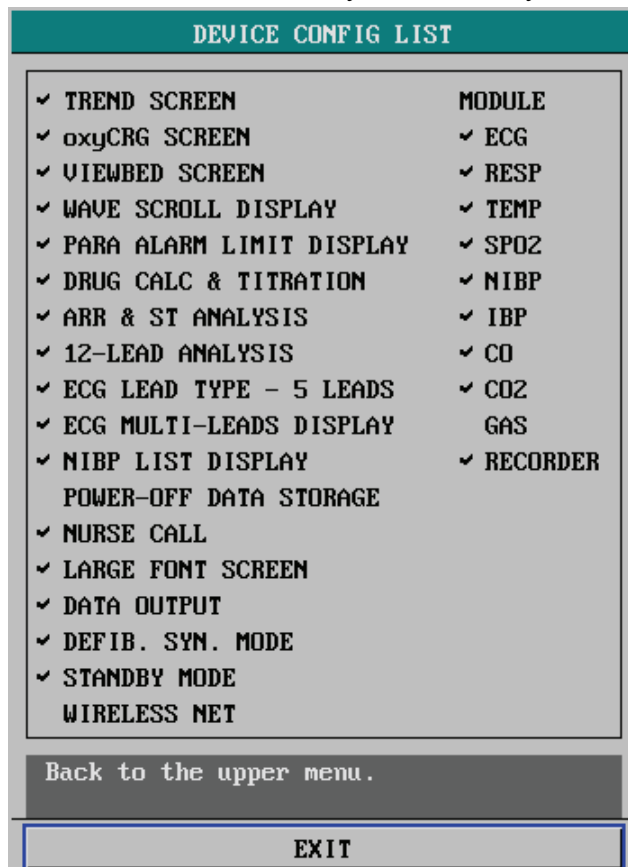


Figure 4-19 Device Configuration List

You can also see the device version by selecting DEVICE VERSION LIST>> as shown below. However, the DEVICE VERSION LIST menu of you monitor may be different.

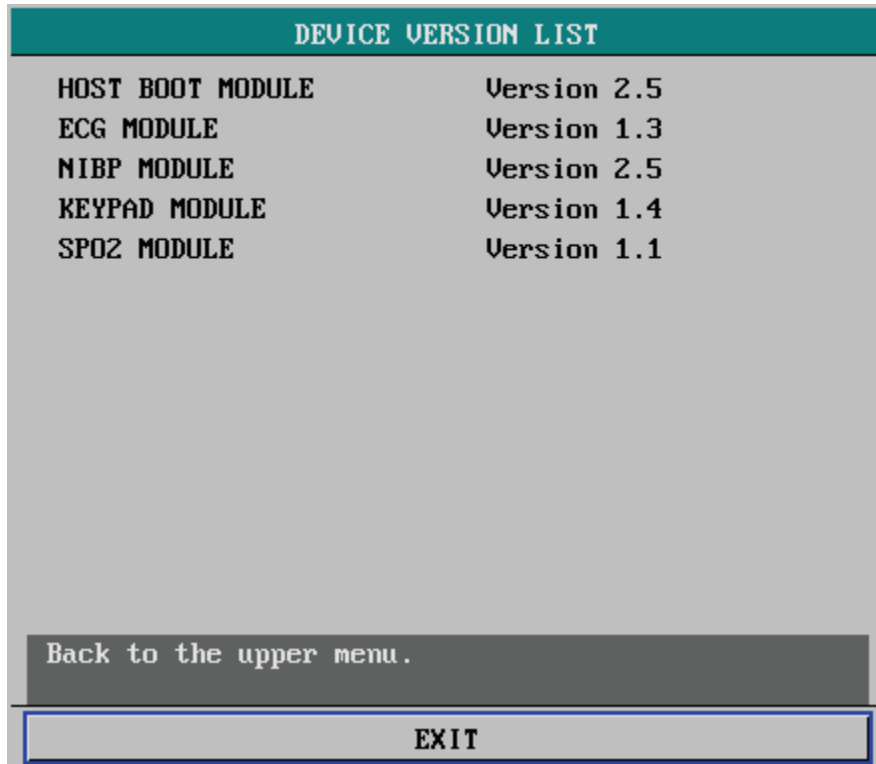


Figure 4-20 Device Version List

4.7 Maintenance

Select MAINTAIN>> in SYSTEM MENU. The following menu appears.

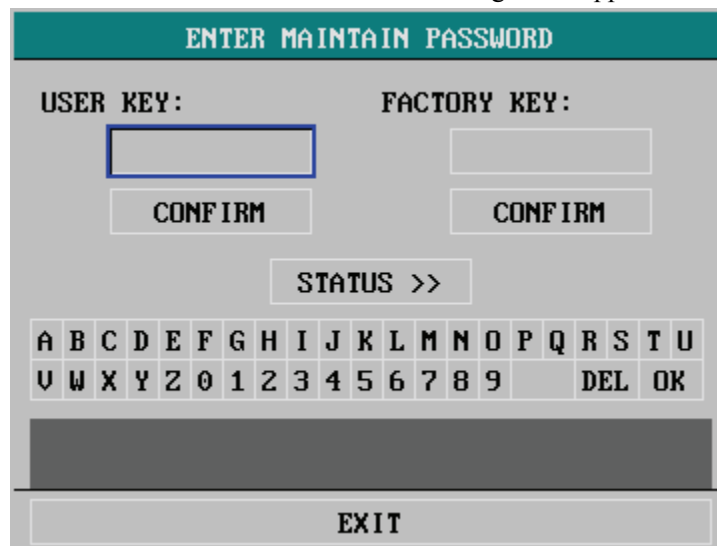


Figure 4-21 Enter Maintain Password

Enter USER KEY, then select CONFIRM button. The following menu appears.

USER MAINTAIN																																													
MONI NAME	<input type="text"/>	POWERON CONF	LAST CONF ▾																																										
DEPT.	<input type="text"/>	SAVE AS USER CONFIG																																											
BED NO	<input type="text"/>	ALARM SETUP >>																																											
NET TYPE	CMS+ ▾	IP ADDRESS SETUP >>																																											
LOCAL NET NO	1 ▾	WIRELESS NET SETUP >>																																											
NOTCH FREQ.	50HZ ▾	COLOR SELF-DEFINE >>																																											
LANGUAGE	ENGLISH ▾	NURSE CALL SETUP >>																																											
AUX OUTPUT	ANALOG OUT ▾	CO2 USER MAINTAIN >>																																											
LEAD NAMING	AHA ▾	GAS CALIBRATE >>																																											
IBP PRESSURE CALIBRATE																																													
<table border="1"> <tr> <td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td><td>I</td><td>J</td><td>K</td><td>L</td><td>M</td><td>N</td><td>O</td><td>P</td><td>Q</td><td>R</td><td>S</td><td>T</td><td>U</td> </tr> <tr> <td>V</td><td>W</td><td>X</td><td>Y</td><td>Z</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td></td><td></td><td>DEL</td><td>OK</td><td></td><td></td> </tr> </table>				A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	0	1	2	3	4	5	6	7	8	9			DEL	OK		
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U																									
V	W	X	Y	Z	0	1	2	3	4	5	6	7	8	9			DEL	OK																											
Enter max. 12 characters. DEL: delete the current character. OK: confirm the entered information.																																													
EXIT																																													

Figure 4-22 User Maintain

You can perform the following settings:

- MONI NAME Monitor's name.
- DEPT. The department where the monitor is located.
- BED NO The bed number where the monitor is located.
- NET TYPE Network type
Options: CMS and CMS+.
- LOCAL NET NO It indicates the bed number of a monitor in the monitoring network. If the NET TYPE is CMS, the LOCAL NET NO can be set between 1 and 64.
- NOTCH FREQ. Options: 50Hz and 60Hz;
If NOTCH is turned ON, the monitor filters the ECG signals with the selected notch frequency.
- LANGUAGE Select the required language of the displayed texts.
- AUX OUTPUT Three options are available:

-
1. ANALOG OUT (analog output)
 - ◆ If this option is selected, the auxiliary output port will be able to output analog signals, and you can perform the settings in the ANALOG menu. For details, see **4.4.6 Analog Output**.
 - ◆ If this option is not selected, the analog output function will be disabled and the ANALOG >> option in the SYSTEM SETUP menu will become inactive. In this situation, you cannot set the information in the ANALOG menu.

 2. NURSE CALL
 - ◆ If this option is selected, the auxiliary output port will be able to output nurse call signals, and you can perform the settings in the NURSE CALL SETUP submenu of the USER MAINTAIN menu. For details, see **4.7.4 Nurse Call Setup**.
 - ◆ If not selected, the nurse call function will be disabled and the NURSE CALL SETUP>> option in USER MAINTAIN will become inactive. In this situation, you cannot set the information in the NURSE CALL SETUP submenu.

 3. DEFIB. SYN (defibrillator synchronization signals)
 - ◆ If this option is selected, the auxiliary output port will be able to output defibrillator synchronization signals. In this situation, you can turn on DEFIB SYNC in the ECG SETUP menu to enable the defibrillator synchronization. For details, see **10.4 ECG Setup Menu**.
 - ◆ If not selected, the defibrillator synchronization function will be disabled and the DEFIB SYNC option in the ECG SETUP menu will set to OFF (it will not be user-adjustable).

- LEAD NAMING Options: AHA and EURO;

- POWERON CONF1 It indicates the configuration to be loaded when the monitor is powered on. The options are LAST CONF, USER ADU CONF, USER PED CONF and USER NEO CONF.
 LAST CONF is the real-time configuration that is selected before the monitor is last turn off. If the user configuration of a patient type is not saved, the factory configuration of this type will be loaded.
 If the time interval between turnoff and turnon is less than 60 seconds, LAST CONF is automatically restored when the monitor is restarted. If this time interval is greater than 120 seconds, the setting of POWERON CONF will be loaded when the monitor is restarted.

- SAVE AS USER CONFIG You can change the monitor's settings and save the changed settings as user configuration of this patient type so that you can load the user configuration when a new patient is admitted.
 You can restore the saved user configuration in the CONFIG menu or set it as POWERON CONF1.

NOTE

- If you changed the net type and language, the settings take effect only after you restart the monitor.
 - The setting of the notch frequency can neither be saved as the user configuration nor changed when the factory configuration is selected. Once set by a user, no operation except for manual adjustment can change it. The setting keeps the same even when the monitor is restarted.
 - Do not change the BED NO when your monitor is using the wireless network feature.
-

4.7.1 Alarm Setup

Select ALARM SETUP>> to enter the following menu:

The screenshot shows the 'ALARM SETUP' menu with the following settings:

Setting	Current Value
ALARM SOUND OFF	DISABLE
AUDIO MODE	MODE1
PARA ALM TYPE	UNLATCH
REMINDER TONE	ON
REMINDER INTERVAL	1MIN
ECG LEAD OFF	LOW
SPO2 SENSOR OFF	LOW

Below the settings is a message: "Enable/disable the ALARM SOUND OFF setting." and an "EXIT" button at the bottom.

Figure 4-23 Alarm Setup

- | | |
|-------------------------------|--|
| ■ ALARM SOUND OFF | ENABLE: ALARM VOL can be set to 0.
DISABLE: ALARM VOL cannot be set to 0. |
| ■ AUDIO OFF | MODE 1: the alarm sound interval of high level alarm is 8s and that of medium level alarm is 24s.
MODE 2: the alarm sound interval of high level alarm is 3s and that of medium level alarm is 14s. |
| ■ PARA ALM TYPE | LATCH, UNLATCH |
| ■ REMINDER TONE | Options: ON,OFF. |
| ■ REMINDER INTERVAL | Options: 1MIN, 2MIN and 3MIN. |
| ■ ECG LEAD OFF | Alarm level: HIGH, MED, LOW. |
| ■ SpO ₂ SENSOR OFF | Alarm level: HIGH, MED, LOW. |

NOTE

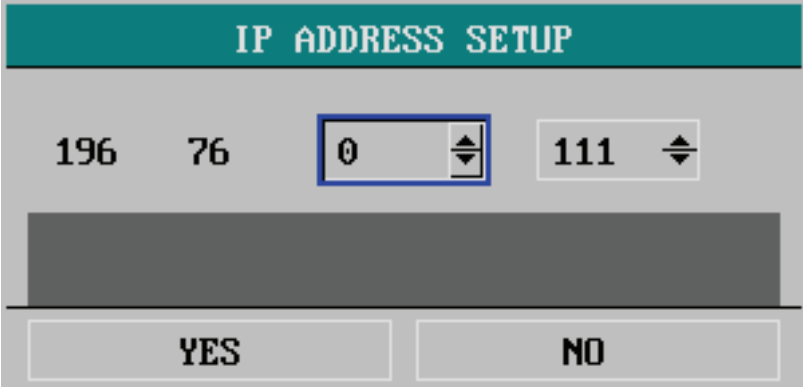
- In the case that alarm volume is set to 0, if you set **ALARM SOUND OFF** to **DISABLE**, alarm volume change to the default.
-

WARNING

- Select the setting of **ALARM SOUND OFF** with caution.
-

4.7.2 IP Address Setup

When the monitor is connected with the central monitoring system, and the NET TYPE is CMS+, you need to set the IP address of your monitor. Select IP ADDRESS SETUP in USER MAINTAIN menu. The following menu appears. For details, please contact with the technician responsible for the central monitoring system in your hospital.



IP ADDRESS SETUP

196 76 0 111

YES NO

Figure 4-24 IP Address Setup

4.7.3 Self Definition of Color

Select COLOR SELF-DEFINE >> in USER MAINTAIN menu. The following menu appears.

The screenshot shows a menu titled "COLOR SELF-DEFINE" with a teal header. Below the header is a table of parameters and their assigned colors. Each color is shown in a dropdown menu. The "EGC" dropdown is highlighted with a blue border. Below the table is a grey bar with the text "Display ECG wave & para. in selected color." and an "EXIT" button at the bottom.

COLOR SELF-DEFINE			
ECG	GREEN	CO2	YELLOW
SPO2	CYAN	AG O2	---
IBP1	RED	AG N2O	BLUE
IBP2	PURPLE	AG AA	YELLOW
RESP	YELLOW	OTHER PARA	WHITE

Display ECG wave & para. in selected color.

EXIT

Figure 4-25 Self-definition of color

This menu allows you to choose in which color the waveform(s) and parameter(s) of a parameter module are to be displayed.

- OTHER PARA refers to the parameters, NIBP and TEMP, which do not have waveform.
- CO2 refers to the parameters measured by CO2 module or AG module.
- AG O2, AG N2O and AG AA refer to corresponding parameters measured by AG module.
- AA refers to the used anesthetic agent. If the anesthetic agent is available before opening the COLOR SELF-DEFINE menu, the name of the anesthetic agent will be displayed instead of AA.

NOTE

-
- Your monitor may not include all parameters.
-

4.7.4 Nurse Call Setup

Select NURSE CALL SETUP >> in USER MAINTAIN menu. The following menu appears.

The screenshot shows a terminal-style interface for 'NURSE CALL SETUP'. The title bar is teal with white text. The main area is grey with white text. 'SIGNAL DURATION' is a dropdown menu with 'CONTINUUM' selected. 'SIGNAL TYPE' is a dropdown menu with 'NORMAL CLOSE' selected. 'ALM LEV' has three radio button options: 'HIGH', 'MED', and 'LOW'. 'ALM TYPE' has two radio button options: 'TECH.' and 'PHYS.'. At the bottom, there is a grey bar with the text 'Select Nurse call signal duration.' and a button labeled 'EXIT'.

Figure 4-26 Nurse Call Setup

You can perform the following settings:

■ SIGNAL DURATION

Two options are available: PULSE, and CONTINUUM.

1. PULSE

When pulse is selected, a nurse call signal is a pulse signal lasting 1s. When multiple alarms occur simultaneously, only one pulse signal will be output. If an alarm comes out before the previous alarm is cleared, another pulse signal will be output.

2. CONTINUUM

When continuum is selected, the duration of a nurse call signal is the same with the alarm, namely, from the time that the alarm occurs to the time it disappears.

■ SIGNAL TYPE

1. NORMAL OPEN: Select this option when the hospital's call system is set to NORMAL OPEN.
2. NORMAL CLOSE: Select this option when the hospital's call system is set to NORMAL CLOSE.

■ ALM LEV

Alarm level

Options: HIGH, MED (medium) and LOW.

More than one option can be selected at one time.

■ ALM TYPE

Alarm type

Options: TECH. (technical) and PHYS. (physiological).

Both options can be selected at one time.

Trigger Conditions

A nurse call signal will be triggered only if all the following conditions are met:

1. The nurse call function is enabled.
2. An alarm of the preset alarm level and alarm type comes out.
3. The monitor is not in the Alarms Paused or the System Silenced status.

NOTE

-
- **If no option in ALM LEV or ALM TYPE is selected, the nurse call signal will not be triggered in whatever condition.**
 - **The nurse call function can't be used as the main alarm notice method. Medical staff must combine the audible and visual alarms, the clinical vital signs of the patient to determine the patient's situation.**
 - **In the Alarms Paused or the System Silenced status, the nurse call function of the monitor will be disabled automatically.**
-

4.7.5 IBP Pressure Calibration

The monitor provides the function of IBP pressure calibration.

4.7.6 CO₂ User Maintain

Selecting CO₂ USER MAINTAIN >> in USER MAINTAIN menu opens the CO₂ USER MAINTAIN menu. The options contained in this menu are relative with the CO₂ module that you monitor is equipped with. For details, please refer to chapter *CO₂ Monitoring*.

4.7.7 Gas Calibrate

Selecting GAS CALIBRATE >> in USER MAINTAIN menu opens the GAS CALIBRATE menu. The options contained in this menu are relative with the AG module that you monitor is equipped with. For details, please refer to chapter *Anesthesia Gas Monitoring*.

4.7.8 Monitor Status

Select STATUS >> in ENTER MAINTAIN PASSWORD menu. The following menu appears.

The screenshot shows a terminal window titled "STATUS". It contains a list of 10 status messages, each with a number, a description, a date, and a time. Below the list are two buttons: "UP-DOWN" and "REC". A message below the buttons says "Page up/down to view more information of device status.". At the bottom is an "EXIT" button.

STATUS			
1.	STARTUP TIME	06-08-2007	13:41:25
2.	IBP(1,2) INIT ERR	06-08-2007	13:41:25
3.	IBP(1,2) SELFTEST ERROR	06-08-2007	13:41:25
4.	CO INIT ERR	06-08-2007	13:41:25
5.	CO SELFTEST ERROR	06-08-2007	13:41:25
6.	CO2 SELFTEST ERROR	06-08-2007	13:41:25
7.	IBP(1,2) COMM ERROR	06-08-2007	13:41:26
8.	CO2 COMM ERROR	06-08-2007	13:41:26
9.	CO COMM ERROR	06-08-2007	13:41:26
10.	REC SELFTEST ERROR	06-08-2007	13:41:41

UP-DOWN REC

Page up/down to view more information of device status.

EXIT

Figure 4-27 Monitor Status

- UP-DOWN This menu can display a maximum of ten status messages. In case of more than ten, you can select UP-DOWN to learn other status messages.
- REC Recording
You can select the REC option to record the status message displayed.

4.8 DEMO Function

Select DEMO >> in SYSTEM MENU. The following menu appears.

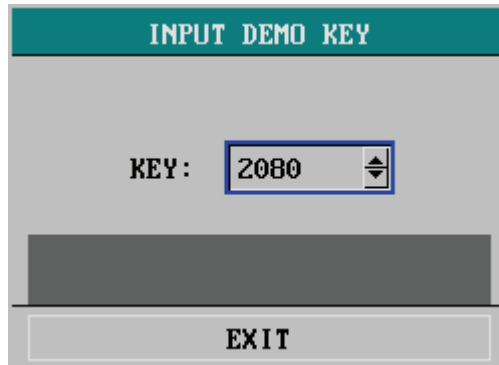


Figure 4-28 Input Demo Key

The monitor enters the demonstration mode when the correct password is input in the menu above. The word DEMO will be displayed on the main screen. The purpose of the demonstration display is to demonstrate the performance of the monitor, and for training purposes.

WARNING

- **In clinical applications, this function is forbidden because the DEMO display can mislead the medical staff to treat the DEMO waveforms and parameters as the actual data of the patient. This may result in serious injury to the patient, or a delay of treatment or improper treatment.**
-

5 Face Selection

5.1 Standard Screen

You can open the FACE SELECT menu by selecting FACE SELECT >> in SYSTEM SETUP menu.

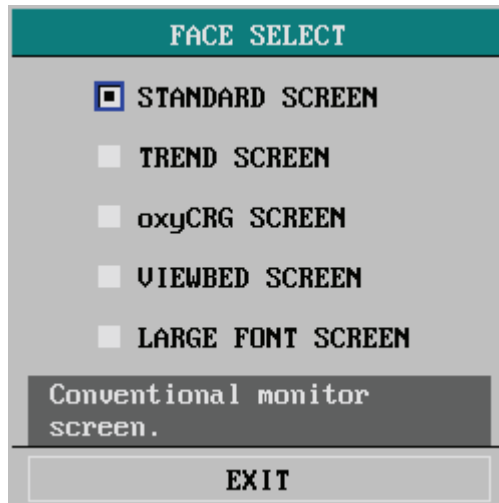


Figure 5-1 Face Select

The standard screen is the default screen. If the current screen is not the standard screen, you may enter the standard screen by selecting STANDARD SCREEN and then selecting EXIT in FACE SELECT menu. For more information about the standard screen, see [2.4 Display](#).

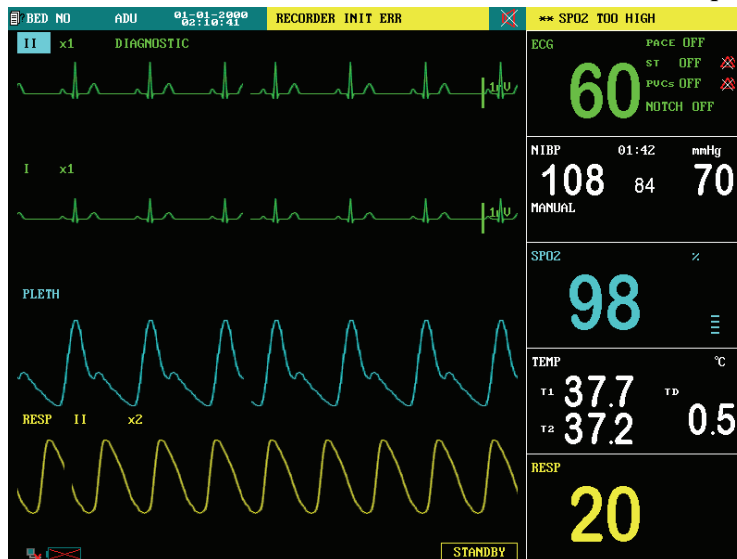


Figure 5-2 Standard Screen

5.2 Trend Screen

To enter the following screen, select TREND SCREEN in FACE SELECT menu and then select EXIT.

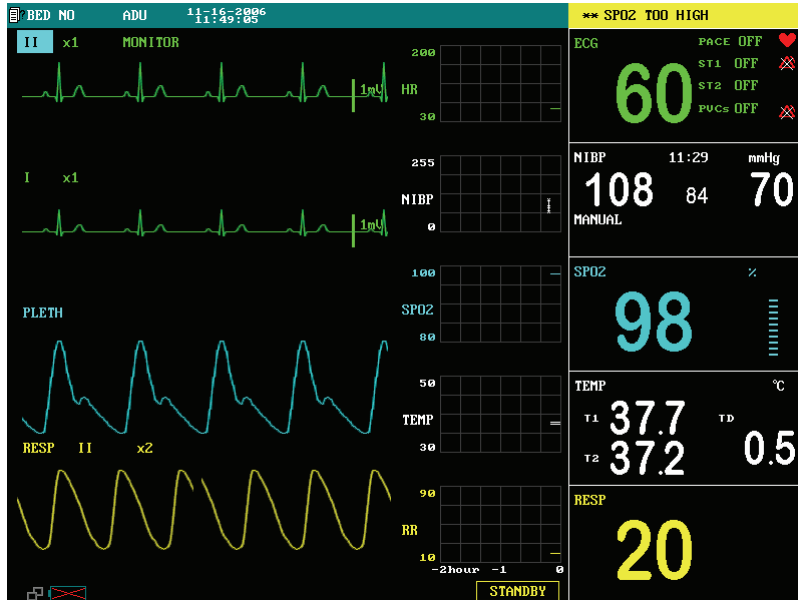


Figure 5-3 Trend Screen

■ Trend graph

Trend graphs locate to the right of the corresponding waveform in the waveform area, and display the trends of one parameter of each module. The parameter labels, as well as their scales, are displayed to the left of the trend graph.

■ Trend length

The dynamic trend length, located below the trend graph, is 2 hours. On the trend graph, the scale of the right end of the X-axis is 0 hour while the left end is -2 hour.

■ Selecting a trend parameter

If a module has multiple trend parameters, you can select one from the parameter label options of the corresponding trend graph. The trend graph of the selected parameter will be displayed.

5.3 OxyCRG Screen

To enter the following screen, select oxyCRG SCREEN in FACE SELECT menu and then select EXIT.

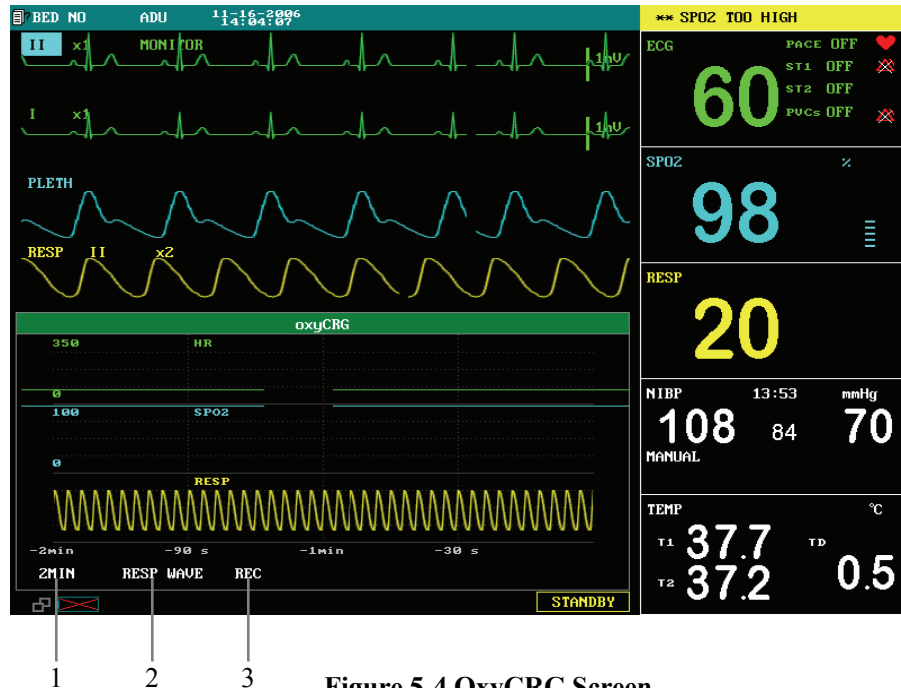


Figure 5-4 OxyCRG Screen

Oxy CRG screen is located at the lower part of the waveform area, consisting of the HR trend, the SpO₂ trend, and the RR (respiration rate) trend or the compressed respiration waveform. Below the RR trend or the compressed respiration waveform is the scale of the trend time. In addition, three labels are displayed beneath the time scale (see 1, 2 and 3 in the figure above). The labels are detailed as below.

1. Trend length
This label allows you to select the time duration of the trend graphs displayed. You can select either 1 MIN, 2 MIN or 4 MIN.
2. Compressed respiration waveform/RR trend
With this label, you can select to display the compressed respiration waveform or the RR trend beneath the SpO₂ trend.
3. Recording
You can select the REC label to print out the trends or the waveform displayed in the oxyCRG screen using the recorder.

5.4 Viewbed Screen

This monitor can view one parameter waveform and measured data from another patient monitor (viewbed monitor) on the same monitoring network. To enter the following screen, open FACE SELECT menu, select VIEWBED SCREEN, and then select EXIT. When connecting by wireless network (if your monitor has this feature), viewbed function is disabled.

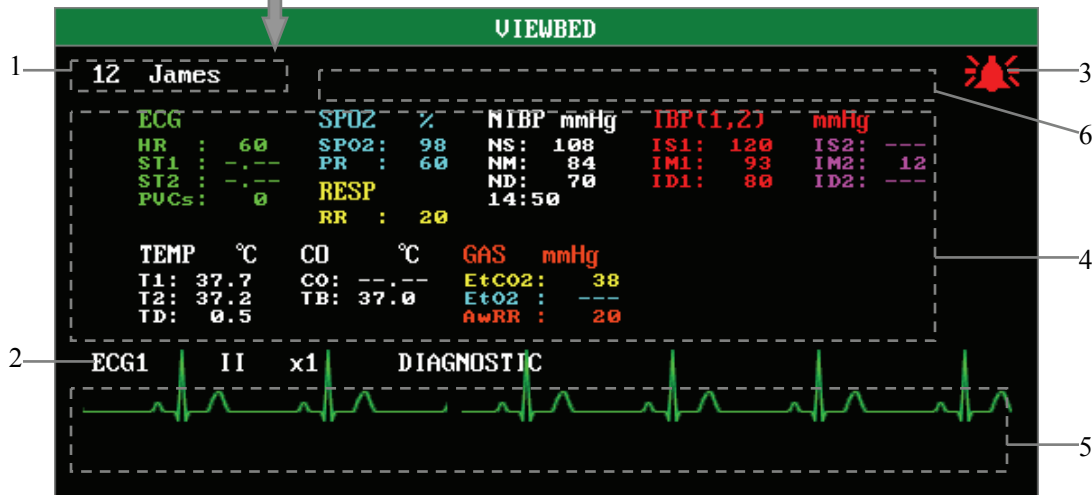
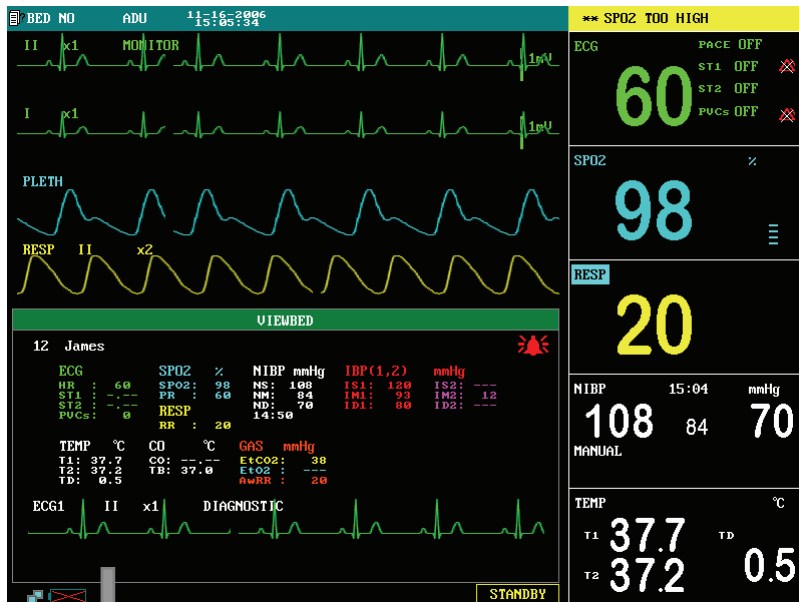


Figure 5-5 Viewbed Screen

The monitor you are viewing from is called “host monitor”. The monitor being viewed is called “viewbed monitor”. The viewbed screen is always displayed at the lower part of the host monitor’s waveform area. As shown in *Figure 5-5*, it consists of the following parts.

-
1. Viewbed monitor label
The viewbed monitor label allows you to select the viewbed monitor you want to view. It displays the bed number and patient name of the viewbed monitor. If they are not entered, the label displays blank. If the host monitor is not connected with any other monitor on the same network, the label displays N/A.
 2. Viewbed waveform label
The viewbed waveform label allows you to select a waveform of the viewbed monitor. If the viewbed monitor does not display any waveform, this label displays N/A.
 3. Viewbed alarm indicator
The viewbed alarm indicator in the viewbed screen is used to indicate the alarm status of the viewbed monitor. Its color is identical with that of the viewbed monitor.
 4. Viewbed parameter area
All parameter data of the viewbed monitor is displayed in this area.
 5. Viewbed waveform area
The viewbed waveform area is located beneath the viewbed waveform label. It displays the waveform selected through the viewbed waveform label. The scan type (either refresh or scroll) and the sweep speed of the viewbed waveform follow the host monitor. Besides, information relating to the viewbed waveform is shown above the waveform.
 6. Technical information area
On the right of the viewbed monitor label is the technical information area. It shows the technical information about viewing of other patient, such as the prompt information indicating failure in viewing other patient due to network problems.

Automatic Selection

When the viewbed screen is opened, the host monitor automatically selects a viewbed monitor on the same network and a waveform of this monitor to view. In case the monitor being viewed is disconnected, the host monitor automatically closes the display of alarms, parameters and the waveform of the viewbed monitor. However, the host monitor will not automatically select to view other monitor. You must make the selection using the viewbed monitor label manually.

If a parameter module of the viewbed patient monitor is turned off or disassembled, the corresponding waveform displayed on the host monitor disappears, and the viewbed waveform area becomes blank. At this time, you can use the viewbed waveform label to view other waveform.

5.5 Large Font Screen

To enter the following screen, open FACE SELECT menu, select LARGE FONT SCREEN, and then select EXIT.

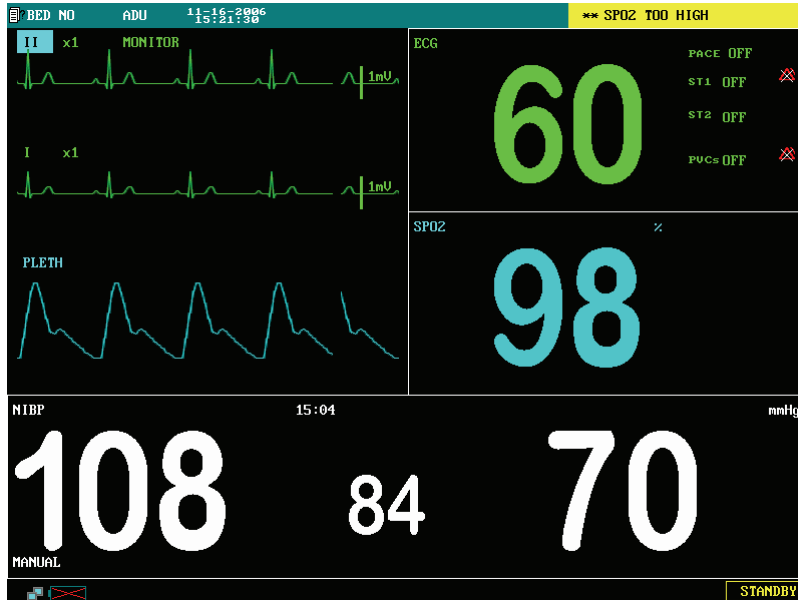


Figure 5-6 Large Font Screen

As shown above, the HR, SpO₂ and NIBP values (diastolic pressure, mean pressure and systolic pressure) are displayed in large font. The ECG and SpO₂ waveforms are displayed on the upper left of the screen. In case the ECG, SpO₂ or NIBP parameter module is turned off, the corresponding parameters and waveform disappear. If all the three modules are closed, no waveform or parameter is displayed on the screen.

NOTE

- When you open a menu in the large font screen mode, the monitor will enter the standard screen automatically. When you exit the menu, the monitor will return to the large font screen.
 - If MULTI-LEADS DISPLAY is selected in the ECG SETUP menu, the monitor cannot enter the large font screen.
-

5.6 Standby Mode

During patient transport or temporary departure of a patient, the monitor can be set to STANDBY mode. In this mode, the monitor suspends the monitoring and measurement on the patient and shields all alarm indications. Besides the WORK MODE of CO₂ and AG module (if available), which will also be changed to STANDBY, the previous menu settings and patient information keep unchanged.

Entering the STANDBY mode

1. Disconnect all leads and sensors between the patient and the monitor.
2. Select the STANDBY label at the lower right corner of the main screen. A dialog box pops up, and you can choose to enter the standby mode or not.
3. Select YES, and the monitor will enter the standby mode as shown below.
4. Select NO, and the monitor will return to the previous screen.



Figure 5-7 Standby Mode

Exiting the STANDBY mode

Press any key other than the power switch on the control panel or turn the control knob in the STANDBY mode, and a dialog box will pop up. Select YES in the dialog box, and you will exit the STANDBY mode and return to the previous screen.

FOR YOUR NOTES

6 Alarms

6.1 Overview

The monitor gives audible or visual alarms to indicate the medical staff, when a vital sign of the patient appears abnormal, or mechanical or electrical problems occur to the monitor.

Upon turning on the monitor, the alarm indicator will flash once in yellow and red. Then, a beep will be heard. This is used to verify the audible and visual alarm function of the monitor. If no beep is heard, or the alarm indicator doesn't flash normally, please do not use the monitor, and contact our customer service.

For details about alarm setup of this monitor, please refer to *4.4.2 Alarm Setup*.

6.1.1 Alarm Categories

The alarms are divided into three categories: physiological alarms, technical alarms and prompt information.

1. Physiological alarms

A physiological alarm either indicates that a monitored physiological parameter is out of specified limits or indicates an abnormal patient condition. For example: HR TOO LOW, ECG LOST or RESP ARTIFACT, etc. Physiological alarm messages are displayed in the physiological alarms area of the main screen.

2. Technical alarms

Technical alarms are also referred to as system error messages. A technical alarm indicates that the monitor or parts of the monitor is not capable of accurately monitoring the patient's condition due to improper operation or system failure. For example: ECG INIT ERR or TEMP SELFTTEST ERROR, etc. Technical alarm messages are usually displayed in the technical alarms area of the main screen. But the technical alarms related to NIBP are displayed in the lower part of the NIBP parameter window.

3. Prompt information

Strictly speaking, prompt information cannot be counted in alarms. It is usually information relating to the system, but not concerning vital signs of patients. For example, the monitor prompts "NIBP alarm disabled!" at the time the monitor is powered on. Besides, if a parameter module is turned on but the required leads or sensor are not connected, the monitor will prompt accordingly, such as "ECG LEAD OFF" or "SPO2 SENSOR OFF", etc. Prompt information is usually displayed in the technical alarms area. But the prompt information relating to NIBP is displayed in the lower part of the NIBP parameter window.

NOTE

- **To distinguish from the prompt information, the alarm message is displayed with yellow or red background.**
-

6.1.2 Alarm Levels

The alarms are divided into three priority levels: high level alarms, medium level alarms and low level alarms.

1. High level alarms
 - The patient 's life is in danger and requires emergency treatment, or
 - Serious technical problem occurs to the monitor, such as error in ECG module initialization.
2. Medium level alarms
 - Vital signs of the patient become abnormal, and patient requires immediate treatment, or
 - Certain technical problem occurs to the monitor, such as error in temperature calibration.
3. Low level alarms
 - Certain technical alarm occurs to the monitor, such as ECG lead off in measurement.

The levels of all technical alarms and some physiological alarms are not user-adjustable, because they have been fixed when the monitor is produced. However, you can change the levels of some physiological alarms in the corresponding parameter setup menus.

All physiological alarms, technical alarms and prompt information are given in chapter *Alarm Messages and Prompt Information*.

6.2 Alarm Modes

When an alarm occurs, the monitor raises the user's attention by the following audible or visual indications.

- Visual alarms
- Audible alarms
- Alarm messages
- Parameter flashes
- Reminder Tones

Besides, the visual alarms, audible alarms and alarm messages are given in different ways to identify different alarm levels.

6.2.1 Visual Alarms

The alarm indicator on the front panel of the monitor varies its flash color and frequency to indicate different alarm levels.

- High level alarm: red and quick flash;
- Medium level alarm: yellow and slow flash;
- Low level alarm: yellow light without flash.

6.2.2 Audible alarms

The monitor uses different alarm tones to indicate different alarm levels.

- High level alarm: “DO-DO-DO--DO-DO---DO-DO-DO--DO-DO”.
- Medium level alarm: “DO-DO-DO”.
- Low level alarm: “DO”.

Different intervals correspond to different alarm levels: High level alarm phonates once every 3 or 8 seconds. Medium level alarm phonates once every 14 or 24 seconds. Low level alarm phonates once every 24 seconds. For details, please refer to *4.7 Maintenance*.

NOTE

-
- **When multiple alarms of different levels occur simultaneously, the monitor selects the alarm of the highest level and gives alarm tone accordingly.**
-

6.2.3 Alarm Messages

Alarm messages are given when alarms occur. The alarm messages are displayed in the physiological alarms area or the technical alarms area in black. For physiological alarms, asterisks are displayed before the alarm messages to identify the alarm level.

- High level alarms: triple asterisks “***”
- Medium level alarms: dual asterisks “**”
- Low level alarms: single asterisk “*”

The monitor varies the background color of the technical and physiological alarm messages to indicate the alarm level.

- High level alarms: red background color
- Medium level alarms: yellow background color
- Low level alarms: yellow background color

NOTE

-
- **Comparing with an alarm message, the background color of prompt information is the same as that of the position where it appears.**
 - **The NIBP technical alarm messages appear in the NIBP parameter window. For high level alarms, the text color is red; for medium and low level alarms, the text color is yellow. The background color is the same as the parameter window.**
-

6.2.4 Parameter Flashes





An alarm is triggered when a patient parameter exceeds the parameter limit. At the same time, the measured parameter value in the parameter window flashes every second. If the ALM LIMIT in the SELECTION menu is turned ON, the exceeded upper or lower alarm limit also flashes every second.

6.2.5 Reminder Tones

When system sounds are silenced or alarm tones are turned off, the patient monitor will give a single beep in case of an active alarm condition. You can set the REMINDER VOL to HIGH, MED or LOW. For details, please refer to **4.4.2. Alarm Setup**. The REMINDER TONE can be turned on or off, and you can set REMINDER INTERVAL as required. For details, please refer to **4.7.1 Alarm Setup**.

6.3 Alarm Statuses


When an alarm occurs, normally the monitor gives indications in the modes mentioned above as per the alarm level. If necessary, you can set the monitor to the following alarm statuses.

-  Alarms Disabled
-  Alarms Paused
-  System Silenced
-  Alarm Sound Off

6.3.1 Alarms Disabled

If the alarm switch of a parameter is turned off, the monitor does not generate alarms even if the measured parameter value exceeds the alarm limit. This status is called Alarms Disabled.

To disable the alarms of a parameter, you should open the setup menu of the parameter. Take heart rate (HR) as an example.


1. Rotate the control knob and highlight the ECG parameter label.
2. Press the control knob. The ECG SETUP menu pops up.
3. Rotate the control knob and highlight the field on the right of HR ALM.
4. Press the control knob, and then select OFF from the pull-down list.
5. The HR alarms are disabled. The  icon will be displayed on the right of the ECG parameter label.

NOTE

- **When a new parameter module is installed or when a parameter module is turned ON, all the parameter alarms and technical alarms related to this module are disabled in the first 30-second operating time. The other module alarms are not influenced.**
-


6.3.2 Alarms Paused

To pause all alarms of the monitor for 1, 2 or 3 minutes, press the SILENCE key on the control panel once (for less than 2 seconds). In Alarms Paused status,

- Visual alarms and audible alarms are both paused.
- The parameters generating physiological alarms and their upper or lower limits stop flashing.
- Alarm messages are not displayed.
- The physiological alarms area shows the rest time of alarms paused status.
- The  icon will be displayed in the sound icon area.


The monitor will not terminate the Alarm Paused status even if a new technical or physiological alarm occurs during the alarms paused time.

6.3.3 System Silenced

To silence the system, press the SILENCE key for no less than 2 seconds. In the System Silenced status, all system sounds are shielded and the  icon is displayed in the sound icon area. However, other modes of alarms (excluding audible alarms) are given as normal. If a new alarm occurs, the System Silenced status will be terminated.

The system sounds include the audible alarms, key tones, heart beat tones and pulse tones. Among them, key tones refer to the sounds produced when the control knob is rotated and pressed.

6.3.4 Alarm Sound Off

In Alarm Sound Off status, all audible alarms are suppressed, but other modes of alarms and other sounds are not influenced. The  icon will be displayed in the sound icon area. To turn off the audible alarms, first access the USER MAINTAIN menu, and then set the ALARM SOUND OFF to DISABLE. For details, please refer to **4.7 Maintenance**.

6.3.5 Status Switchover

1. In the Normal status,
 - Press the SILENCE key for less than 2 seconds to switch to the Alarms Paused status, or
 - Press the SILENCE key for 2 seconds or more to switch to the System Silenced status.

2. In the Alarms Paused status,
 - Press the SILENCE key for less than 2 seconds to switch to the Normal status, or
 - Press the SILENCE key for 2 seconds or more to switch to the System Silenced status.

3. In the System Silenced status,
 - Press the SILENCE key for less than 2 seconds to switch to the Alarms Paused status, or
 - Press the SILENCE key for 2 seconds or more to switch to the Normal status.

4. In the Alarm Sound Off status,
 - Enter the ALARM SETUP menu and set ALARM VOL to any setting other than 0. The alarm sound is restored.
 - Enter the USER MAINTAIN menu and set ALARM SOUND OFF to DISABLE. The system restores the default alarm volume.

6.4 Latching Alarms

As described in *4.7 Maintenance*, the parameter alarm type can be set to either LATCH or UNLATCH.

If the parameter alarm type is set to LATCH, before or during the occurrence of a parameter alarm, the alarm message will be latched even if the initial alarm condition has ceased. The alarm message continues to be displayed, but the alarming modes change as follows:

- The measured parameter value and the upper or lower parameter limit stop flashing.
- The generated time of the alarm is displayed behind the alarm message in the physiological alarms area.

If the parameter alarm type is set to UNLATCH, the monitor stops giving any indication for this alarm when the initial alarm condition has ceased.

6.5 Clearing Alarms

Generally the alarm indications of an alarm will automatically be cleared when the alarm condition that triggered the alarm ceases. However, you can also clear the alarm indications or the latched alarms by the following ways.

1. Clearing audible and visual alarm indications

For some technical alarms, the audible and visual alarm indications will be cleared if the monitor is set to the Alarms Paused status (by pressing the SILENCE key for less than 2 seconds), and the alarm message will be changed to prompt information during and after the alarms paused time. If the technical alarm is triggered again after the monitor restores to the normal status, the monitor will give alarming indications as normal.

Please refer to chapter *Alarm Messages and Prompt Information* to see for which technical alarms that the audible and visual indications can be cleared.

2. Clearing all alarm indications

For some technical alarms, if the monitor is set to the Alarms Paused status (by pressing the SILENCE key for less than 2 seconds), all alarm indications will be cleared during and after the alarms paused time. If the technical alarm is triggered again after the monitor restores to the normal status, the monitor gives alarming indications as normal.

Please refer to chapter *Alarm Messages and Prompt Information* to see for which technical alarms that all alarm indications can be cleared.

3. Clearing latched alarms

Clearing latched alarms is also referred to as resetting alarms. It refers to clear the latched alarms by setting the monitor to the Alarms Paused status (by pressing the SILENCE key for less than 2 seconds).

6.6 Testing Alarms

When the monitor starts up, a selftest will be performed automatically. The alarm indicator will flash once in yellow and red. Then, the system gives a beep indicating that the visible and audible alarm indicators are functioning correctly. The start-up screen is displayed.

For further testing of individual measurement alarms, perform the measurement on yourself (for example SpO2 or CO2) or use a simulator. Adjust alarm limits and check if alarms behave correctly.

6.7 When an Alarm Occurs

WARNING

- **When an alarm occurs, always check the patient's condition first.**
-
-

When an alarm occurs to the monitor, refer to the following steps and take action properly.

1. Check the patient's condition.
2. Identify the alarming parameter and the alarm category.
3. Identify the cause of the alarm.
4. Take action to remedy the alarm cause.
5. Check if the alarm is cleared.

For details about how to deal with specific alarms, see chapter *Alarm Messages and Prompt Information*.

7 Freezing Waveforms

7.1 Overview

You can freeze the monitored waveforms of a patient as desired and view the waveforms of 40 seconds to gain a clear observation. Besides, the monitor can print three frozen waveforms using the recorder.

The freezing function of the monitor has the following features.

- When the monitor enters the frozen mode, it exits all other menus automatically.
- The system freezes all waveforms displayed in the waveforms area.
- The frozen waveforms can be reviewed and recorded.

7.2 Freezing and Unfreezing

Entering the Frozen Mode

1. Press the FREEZE key on the control panel when the monitor is not in frozen mode.
2. The system exits all displayed menus (if displayed), and the FROZEN menu pops up.



Figure 7-1 Frozen Menu

3. All displayed waveforms are frozen. In other words, the waveforms stop being refreshed or scrolling.

Exiting the Frozen Mode

To exit the frozen mode,

- Select EXIT in the FROZEN menu, or
- Press the FREEZE key on the control panel again.

After exiting the frozen mode, all waveforms on the screen are cleared and new real-time waveforms are displayed. If the scan type of the monitor is set to REFRESH, the waveforms are refreshed from the left of the waveforms area to the right ; if the scan type is set to SCROLL, the waveforms are displayed from the right of the waveforms area to the left and are scrolling.

7.3 FROZEN Menu

The FROZEN menu is displayed at the lower left corner. You can perform the following settings in this menu.

- WAVE 1 Waveform 1
It determines the first frozen waveform to be printed on the recorder paper. The options of waveform 1 include all waveforms displayed on the screen and OFF. The waveform 1 will not be recorded when OFF is selected.
- WAVE 2 Waveform 2
It determines the second frozen waveform to be printed on the recorder paper. The options of waveform 2 include all waveforms displayed on the screen and OFF. The waveform 2 will not be recorded when OFF is selected.
- WAVE 3 Waveform 3
It determines the third frozen waveform to be printed on the recorder paper. The options of waveform 3 include all waveforms displayed on the screen and OFF. The waveform 3 will not be recorded when OFF is selected.
- RECALL Waveform recall
It changes to L-RIGHT when selected. At this time, you can rotate the control knob to view the frozen waveform.
- REC Record
When selected, the recorder starts printing out the selected waveform 1, waveform 2 and waveform 3.
- EXIT This option allows you to exit the FROZEN menu and unfreeze the waveforms.

7.4 Waveform Recall

1. In the frozen mode, select the RECALL option in the FROZEN menu, and the option name changes to L-RIGHT.
2. Rotate the control knob clockwise, and the frozen waveforms move to the right. At the lower right corner of the first waveform is an arrow pointing upward. The time is indicated below the arrow. The indication "0S" is used to mark the moment when the waveforms were frozen.
3. With the waveforms move to the right, the time mark, in turn, changes to -1S, -2S, -3S...
4. The time mark is applied to all waveforms displayed on the screen.
5. Rotate the control knob anticlockwise, and the waveforms move to the left.

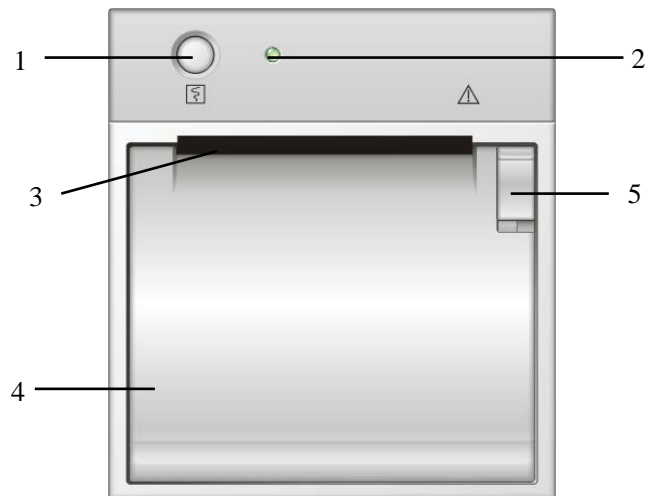
7.5 Recording Frozen Waveforms

1. Select WAVE 1, WAVE 2 and WAVE 3.
2. Select the REC option, and the recorder prints out the selected frozen waveforms and the parameters measured at the moment when the waveforms were frozen.
3. If you set one or two waveforms to OFF, only the waveforms set to ON and corresponding parameter values measured at the moment when the waveforms were frozen will be printed out.
4. If WAVE 1, WAVE 2 and WAVE 3 are all set to OFF, the recorder will not print out any waveform and will merely print out the parameters measured at the moment when the waveforms were frozen.
5. The recording time length is identical to that of the waveforms displayed on the screen. If a waveform is of faster sweep speed, its recording time is shorter.
6. During waveform recording, the monitor is still in frozen mode.
7. When the recording completes, you can select to record other waveforms.
8. If the recorder is not installed, selecting the REC option or pressing the RECORD key triggers the "Recorder does not exit" message, which is displayed in the prompt information area.

FOR YOUR NOTES

Recording

.1 Overview



1. Start/Stop key: this key has no function for this monitor.
2. Indicator
 - ◆ On: when the recorder works correctly.
 - ◆ Off: when the monitor is switched off.
 - ◆ Flashes: if an error occurred to the recorder, e.g., the recorder runs out of paper.
3. Paper outlet
4. Recorder door
5. Latch

A thermal recorder can be equipped with the monitor. The performance of the recorder is described as below.

- Records patient information and parameters.
- Records a maximum of three waveforms.
- The optional recording rates: 25mm/s and 50mm/s.
- The recording grid is optional.
- Multiple recording types are supported.

For details about the recorder setup, please refer to **4.4.4 Recorder Setup**.

, .2 Recording Types

The monitor supports the following types of recordings:

- Real-time recording: continuous real-time recording or 8-second real-time recording.
- Automatic recording.
- Alarm recording: measured parameter alarm recording.
- Frozen waveform recording.
- Trend graph/table recording: trend graph, trend table, NIBP measurement, alarm event or arrhythmia recording.
- Titration table recording.
- OxyCRG recording.
- Monitor status information recording.

Real-time recording

Pressing the RECORD key on the control panel, the real-time recording starts and the current parameters and waveforms are recorded. As described in **4.4.4Recorder Setup**, you can set the RT REC TIME to 8S or CONTINUUM in the RECORD menu. You can also select the three waveforms (REC WAVE 1, REC WAVE 2 and REC WAVE 3) to be recorded. If one or two of the three waveforms is set to OFF, the recorder will merely print out the waveforms set to ON and all the measured parameters; if all the three waveforms are set to OFF, the recorder will only print all the measured parameters.

Automatic recording

The monitor starts recording at the selected interval (TIMING REC TIME) and record for 8s waveforms automatically. For details, see **4.4.4Recorder Setup**.

Alarm recording

Alarm recording is measured parameter recording.

When a parameter alarm occurs, the recorder automatically records two waveforms of 8, 16 or 32 seconds (respectively 4, 8 or 16 seconds before and after the alarm. See **4.4.2 Alarm Setup**) and some measured parameters.

NOTE

- For a parameter alarm recording, you must first set the ALM and ALM REC options to ON.
-

Frozen waveform recording

In the frozen mode, the monitor can print the frozen waveforms displayed on the screen and the parameters measured at the moment when the waveforms were frozen. For details, see [7.5 Recording Frozen Waveforms](#).

Trend graph/table recording

When the trend graph/trend table or a recall window is opened, you can select the REC option to print out the trend graph, trend table, NIBP measurement, alarm event or arrhythmia event.

OxyCRG recording

In the oxyCRG screen, you can press the RECORD key on the control panel to print the three trend graphs or waveforms from the recorder.

Monitor status information recording

The REC option in the STATUS menu allows you to print the status information of the monitor.

, .3 Recorder Operations

Continuous real-time recording

1. Press the RECORD key to start recording.
2. Press the RECORD key again to stop the recording.

8-second real-time recording

1. Press the RECORD key to start recording.
2. The recording stops automatically in 8 seconds.

Automatic recording

1. The recorder starts recording automatically at the preset interval (RT REC TIME).
2. The recording stops automatically in 8 seconds.

Alarm recording

1. When an alarm occurs, the recorder starts recording automatically.
2. The recording stops automatically when the preset alarm recording time (ALM REC TIME) is over.

Frozen waveform recording

1. Press the FREEZE key to open the FROZEN menu.
2. Select WAVE 1, WAVE 2 and WAVE 3.
3. Select the REC option to record.
4. When the recording completes, the recorder stops automatically.

Trend graph recording

1. Select TREND GRAPH>> in SYSTEM MENU to open the TREND GRAPH window.
2. Select the REC option to start recording.
3. When the recording completes, the recorder stops automatically.

Trend table recording

1. Select TREND TABLE>> in SYSTEM MENU to open the TREND TABLE window.
2. Select the REC option to start recording.
3. When the recording completes, the recorder stops automatically.

NIBP measurement recording

1. Select NIBP RECALL>> in SYSTEM MENU to open the NIBP RECALL window.
2. Select the REC option to start recording.
3. When the recording completes, the recorder stops automatically.

Alarm event recording

1. Select ALARM RECALL>> in SYSTEM MENU to open the ALARM RECALL window.
2. Select the alarm recall time in the START and END fields.
3. Select the ALARM RECALL>> option and open the ALARM RECALL window.
4. Select the REC option to start recording.
5. When the recording completes, the recorder stops automatically.

OxyCRG recording

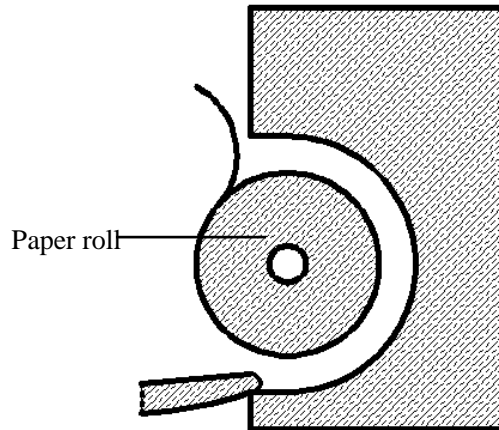
1. Enter the OxyCRG screen.
2. Select the RECORD key when the OxyCRG screen is displayed, and the recorder starts recording.
3. When the recording completes, the recorder stops automatically.

Monitor status information recording

1. Select MAINTAIN >> in SYSTEM MENU, and a popup menu is opened.
2. Select STATUS >> in the popup menu.
3. Select the REC option in the STATUS menu to start recording.
4. When the recording completes, the recorder stops automatically.

, .4 Loading Paper

1. Use the latch at the upper right of the recorder door to pull the door open.
2. Insert a new roll into the compartment as shown below.
3. Close the recorder door.
4. Check if paper is loaded correctly and the paper end is feeding from the top.



CAUTION

- Use only specified thermal paper. Otherwise, it may cause damage to the recorder's printhead, the recorder may be unable to print, or poor print quality may result.
 - Never pull the recorder paper with force when a recording is in process. Otherwise, it may cause damage to the recorder.
 - Do not leave the recorder door open unless you reload paper or remove troubles.
-

Removing Paper Jam

If the recorder works incorrectly or produces unusual sounds, check if there is a paper jam first. If a paper jam is detected, follow this procedure to remove it:

1. Open the recorder door.
2. Take out the paper and tear off the draped part.
3. Reload the paper and close the recorder door.

9 Recall

9.1 Overview

The monitor is able to store important patient data so that the user can review and record the data as desired.

- Trend Graph Recall

You can review the latest 1-hour trend graph of a measured parameter displayed every 1 or 5 seconds, or the latest 96-hour trend graph displayed every 1, 5 or 10 minutes.

- Trend Table Recall

You can review the latest 96-hour trend table data of a measured parameter.

- NIBP Recall

You can review 800 NIBP measurement results, each of which includes a systolic pressure, a mean pressure, a diastolic pressure, a pulse rate and a measurement time.

- Alarm Event Recall

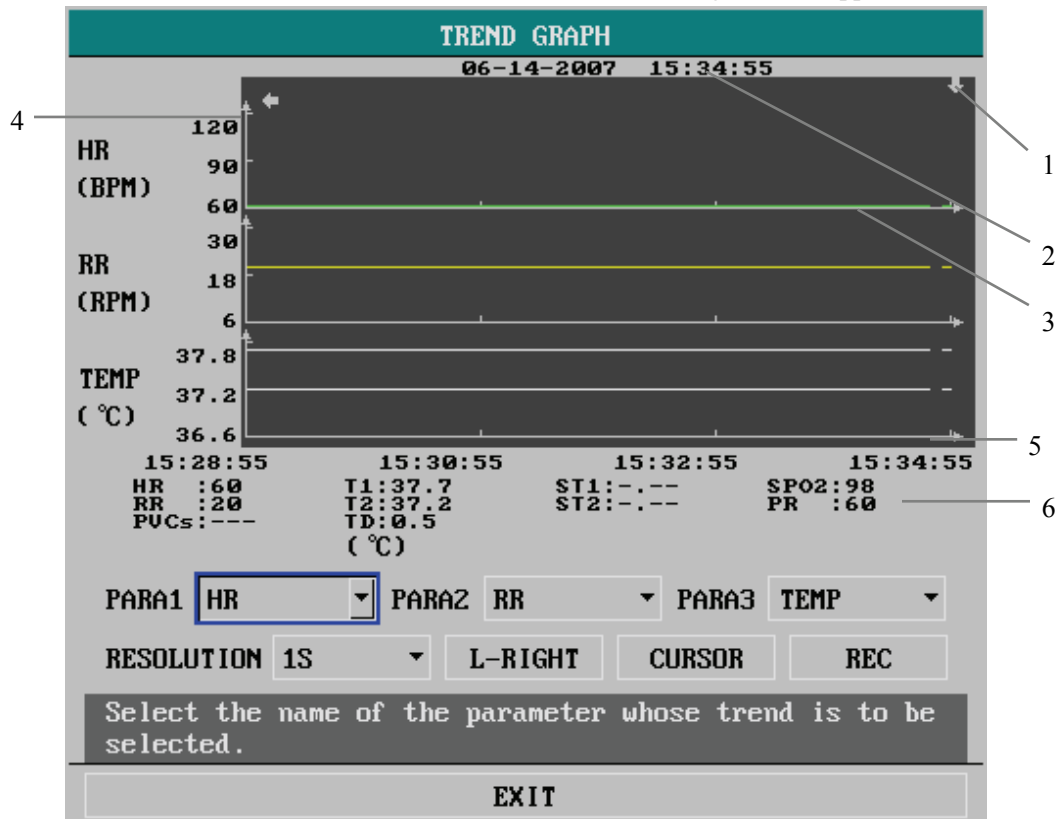
You can review the latest 70 parameter alarm events, as well as the 8, 16, or 32-second waveforms stored at the time of the alarm.

NOTE

-
- **When your monitor is powered off or the power is interrupted accidentally, all the stored data is lost, if the monitor is not equipped with the function of “Power-off Data Storage”.**
-

9.2 Trend Graph Recall

Select TREND GRAPH >> in SYSTEM MENU. The following window appears.



1. Trend cursor
2. Cursor time
3. Trend graph
4. Y-axis
5. X-axis
6. Parameters area

Figure 9-1 Trend Graph

As shown above, PARA1, PARA2 and PARA3 allow you to select a parameter from the options. The trend graph of the selected parameter is displayed. If NIBP is selected, no trend graph is to be displayed. Instead, the ▼ mark indicates the systolic pressure, the ▲ mark indicates the diastolic pressure and the * mark indicates the mean pressure. The x-axis shows the time scale while the y-axis shows the value scale of a parameter. The trend cursor ▾ is used to identify a specific time in the whole trend time, and it is displayed below the title “TREND GRAPH”. All the parameter values measured at the time of the cursor are displayed in the parameters area.

■ PARA SELECT (Parameter Selection)



1. Rotate the control knob and highlight the field at the right side of PARA1, PARA2 or PARA3.
2. Press the control knob, and a popup menu with all parameter options is opened.
3. Rotate the control knob and highlight your desired parameter, and then select it. The trend graph of the selected parameter is displayed in the TREND GRAPH window.

When “OFF” is selected for “PARA1”, “PARA2” or “PARA3”, its trend graph will disappear, and then the trend graphs of other parameters will increase in amplitude and evenly occupy Parameters area. You can not select the same option for “PARA1”, “PARA2” and “PARA3” simultaneously other than “OFF”.

■ RESOLUTION

1. Rotate the control knob and highlight the field at the right of RESOLUTION.
2. Press the control knob, and a menu pops up.
3. Select 1S or 5S to review a 1-hour trend graph, or
4. Select 1MIN, 5MIN or 10 MIN to review a 96-hour trend graph.

■ L-RIGHT

1. Rotate the control knob to highlight the L-RIGHT option, and then press.
2. If the  mark is displayed at the upper left corner of the trend graph, you can rotate the control knob anticlockwise to review the earlier trend graph.
3. If the mark  is displayed at the upper right of the trend graph, you can rotate the control knob clockwise to review the later trend graph.





■ CURSOR

1. Rotate the control knob to highlight the CURSOR option, and then press.
2. Rotate the control knob, and the trend cursor moves as per the preset resolution.
3. The cursor time and the values displayed in the parameters area change accordingly.

■ REC (Recording)

The REC option allows you to print the currently displayed parameters and trend graph from the recorder.

■ Mark Event

If an event is marked A, B, C or D, the mark (, ,  or ) will be displayed at the mark time on the trend graph.

NOTE

-
- The chapter uses "earlier" or "later" to indicate the time that an event happened. For example, May 28 is earlier than May 29, and 8:00 on May 29 is earlier than 9:00 on May 29.
-

9.3 Trend Table Recall

Select TREND TABLE >> in SYSTEM MENU. The following window appears.

TREND TABLE						
TIME	EVENT <	SPO2 (%)	PR (BPM)	NIBP(S/M/D) (mmHg)	TEST AT	>
(14)15:35		98	60	---/---/---		
(14)15:34		98	60	108/ 84/ 70	15:34	
(14)15:33		98	60	---/---/---		
(14)15:32		98	60	---/---/---		
(14)15:31		98	60	---/---/---		
(14)15:30		98	60	---/---/---		
(14)15:29		98	60	---/---/---		
(14)15:28		98	60	---/---/---		
(14)15:27		98	60	---/---/---		
(14)15:26		98	60	---/---/---		
(14)15:25		98	60	---/---/---		
(14)15:24		98	60	---/---/---		

↓

RESOLUTION **1MIN** [v] UP-DOWN L-RIGHT REC

Select the time interval used to view the trend data of the parameter.

EXIT

Figure 9-2 Trend Table



The TIME is displayed on the left of the trend table. On the top is the latest time. From the upper to the lower, the interval between two adjacent times depends on the preset resolution. And the date is contained in the brackets. On the right of the TIME is the EVENT. If a marked event happened at a specific time, the mark will be displayed aside that time in the EVENT field. On the right of the trend table are parameter names and the trend data. The symbol "—" means the parameter is not measured at the corresponding time. Besides, the L-RIGHT option allows change of the parameter name and the trend data.

If you select to review the NIBP trend data, the measurement results as well as the specific measurement time (in the TEST AT filed) are displayed. If more than one measurement results are obtained in a time interval, only one result is to be displayed in the measurement result field.

■ RESOLUTION

1. Rotate the control knob to highlight the field at the right of RESOLUTION.
2. Press the control knob, and a popup value with the options, 1MIN, 5 MIN, 10MIN, 30MIN and 60MIN, is opened.
3. The time displayed in the TIME filed changes with the resolution.

■ UP-DOWN

1. Rotate the control knob to highlight the UP-DOWN option, and press.
2. If the  mark is displayed at the lower right of the TIME field, you can rotate the control knob anticlockwise to page down and review the trend data of earlier time.
3. If the  mark is displayed at the upper right of the TIME field, you can rotate the control knob clockwise to page up and review the trend data of later time.

■ L-RIGHT

1. Rotate the control knob to highlight the L-RIGHT option, and then press.
2. Rotate the control knob to select a parameters set.





The “>” mark on the right of the parameter names indicates the following page is available, and the “<” mark on the left of the parameter names indicates the previous page is available.

3. The parameter names and the trend data changes with the selected parameter set.

■ REC

The REC option allows you to print out the trend data of the currently displayed parameter(s).

■ Mark Event

If an event is marked A, B, C or D, the mark (, ,  or ) will be displayed aside the mark time on the trend table.

9.4 NIBP Recall

Select NIBP RECALL >> in SYSTEM MENU. The following window appears.

The screenshot shows a window titled "NIBP RECALL" with a table of two rows of data. Below the table are controls for "UNIT" (set to mmHg), "UP-DOWN", and "REC". A message "Select the unit of the NIBP measured result." is displayed below the controls, and an "EXIT" button is at the bottom.

	NS	NM	ND	PR	TIME	
1.	108	84	70	60	06-14-2007	15:34:51
2.	108	84	70	60	06-14-2007	15:19:47

NUM: 2 UNIT: mmHg UP-DOWN REC

Select the unit of the NIBP measured result.

EXIT

Figure 9-3 NIBP Recall

The NIBP RECALL window shows the non-invasive systolic pressure (NS), non-invasive mean pressure (NM), non-invasive diastolic pressure (ND), pulse rate (PR) and the measurement time (TIME). The optional pressure units (UNIT) are mmHg and kPa. NUM indicates the current measurement times. PR is derived from NIBP measurements. A maximum of ten measurements can be displayed on the screen once. If there are more, you may use the UP-DOWN option to review the

data of a later or earlier time. If the measurement times surpass 800, only the latest 800 measurements are to be displayed. The REC option allows you to print out all measurement data of NIBP RECALL.

9.5 Alarm Event Recall

Select ALARM RECALL >> in SYSTEM MENU. The following menu appears.

The screenshot shows a terminal-style interface for 'ALARM RECALL CONDITION'. The title bar is teal with white text. Below it, the text 'ALARM RECALL TIME' is displayed. The 'START' field shows a date and time: '2007-6-14 13:41', with each component in a separate box with up/down arrows. The 'END' field has two radio button options: 'CURRENT TIME' (selected) and 'SELF-DEFINE'. Below these are five boxes for defining a custom end time, each with up/down arrows. The 'ALARM RECALL EVENT' field is a dropdown menu currently showing 'ALL'. At the bottom of the main menu area is a button labeled 'ALARM RECALL >>'. Below this is a dark grey bar with white text: 'Select the beginning time of the alarm concerned.'. At the very bottom is a light grey bar with the text 'EXIT'.

Figure 9-4 Alarm Recall Condition Selections

In this menu, you may select the conditions of alarm review:

■ **ALARM RECALL TIME**

You can select the desired start time and end time for review. The end time can be set to either CURRENT TIME or SELF-DEFINE.

■ **ALARM RECALL EVENT**

The drop-down menu of ALARM RECALL EVENT provides a list of parameter options to be reviewed. Among them, ALL indicates all parameter alarm events are to be reviewed, H refers to the upper parameter limit and L refers to the lower parameter limit.

■ **ALARM RECALL>>**

If the ALARM RECALL TIME and the ALARM RECALL EVENT are both selected, you can select the ALARM RECALL >> option to open the ALARM RECALL window as shown in *Figure 9-5*.

This window contains the following information:

1. Time span (the start time and end time of alarm recall).
2. Alarm event type.
3. The alarming parameter, parameter value, alarm level and the alarm time.
4. The alarm event number (format: NO: n of N). N indicates the amount of alarm events and n indicates the sequence number of the currently displayed alarm event.

5. Parameter values at the time of the alarm event.
6. Two waveforms at the time of the alarm event. You can set the waveform length by selecting from the ALM REC TIME options in the ALARM SETUP menu. Please refer to *4.4.2 Alarm Setup*.

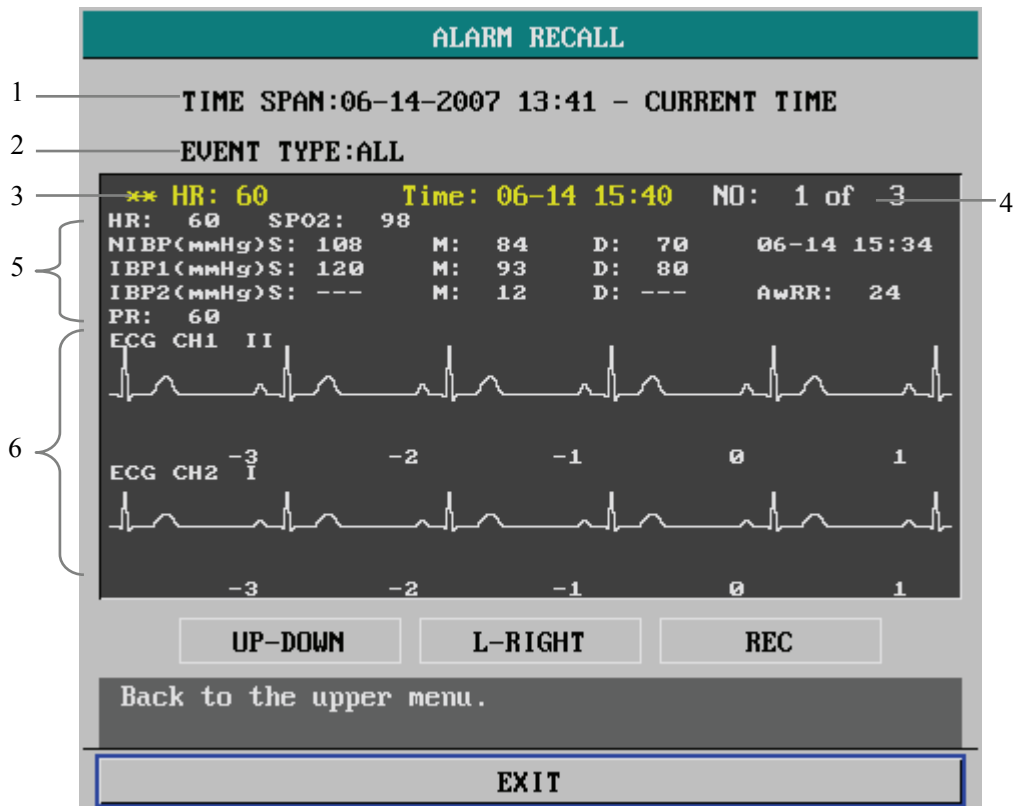


Figure 9-5 Alarm Event Recall

■ UP-DOWN

The monitor is able to store a maximum of 70 alarm events. But only one alarm event can be displayed in the ALARM RECALL window once. You can select the UP-DOWN option and then rotate the control knob to view an earlier or later alarm event.

■ L-RIGHT

You may select the L-RIGHT option and then rotate the control knob to review the 8,16, or 32-second waveforms stored.

■ REC

This option allows you to print out all parameter data and waveforms displayed in the current window using the recorder.

9.6 Non-Volatile Data Storage

To avoid losing patient's data when the monitor is powered off intentionally or accidentally, this monitor can realize the non-volatile data storage function (optional). During monitoring, the patient's data, including trend data, NIBP measurement results, alarm events, and relative waveforms, will be saved into the monitor. When the monitor is powered on again, you can review the saved data using the TREND GRAPH, the TREND TABLE or the NIBP RECALL menu, etc.

FOR YOUR NOTES

10 ECG/RESP Monitoring

10.1 Overview

Two algorithm packages are optional for ECG monitoring:

1. Mindray DS algorithm package
This package provides 3/5-lead monitoring.
2. Mortara algorithm package
This package provides 3/5/12-lead monitoring, ST-segment analysis and extended ARR analysis.

10.2 ECG Monitoring Procedure

10.2.1 Preparation

1. Skin preparation

The quality of ECG information displayed on the monitor is a direct result of the quality of the electrical signal received at the electrode. Proper skin preparation is necessary for good signal quality at the electrode. A good signal at the electrode provides the monitor with valid information for processing the ECG data. Choose flat area to place electrodes. Following is a suggested guideline for skin preparation:

- Shave hair from skin at chosen sites.
 - Gently rub skin surfaces at sites to remove dead skin cells.
 - Thoroughly cleanse the site with a mild soap and water solution (do not use ether or pure alcohol because they will increase skin impedance).
 - Dry the skin completely before applying the electrodes.
2. Attach the ECG leadwire to the electrodes prior to placement.
 3. Place the electrodes on the patient. If the conductive ointment is not applied to the electrodes, apply it before the placement.
 4. Connect the electrode lead to the patient cable.
 5. Make sure the monitor is turned on and is ready for monitoring.

10.2.2 Electrode Placement

WARNING

- Use only the specified ECG cable for monitoring.
 - When applying electrodes or connecting cables, make sure they are not connected to any conductive part or the ground. Verify that all ECG electrodes, including neutral electrodes, are securely attached to the patient.
 - Skin irritation may result from the continuous application of the ECG electrodes. These should be checked each day. If there is an indication of excess skin irritation, replace the electrodes or change the location of the electrodes every 24 hours.
 - Do not touch the patient, bed or instrument during defibrillation.
 - When applying the ECG cable with no resistance to our patient monitor or other patient monitor that has no current limit resistance in it, the monitor cannot be applied to defibrillation.
 - Interference from a non-grounded instrument near the patient and ESU interference can cause inaccuracy of the ECG waveform.
 - Always dispose of, or recycle electrodes properly to prevent from environment contamination.
 - Verify the lead fault detection prior to the start of monitoring. Unplug the ECG cable from the ECG connector and the screen should display the error message “ECG LEAD OFF” and an audible alarm should be activated.
-

NOTE

- The conductive ointment coatings should be isolated, and the chest electrodes should have no contact with each other to avoid short-circuit.
 - Do not use the physiological saline to replace the electrode gel to avoid the electrodes being eroded.
 - Using 3M electrodes is recommended during defibrillation.
-

3-Leadwire Electrode Placement

Following is the configuration per European standard when using three leadwires:

- R (right arm) electrode: near the right shoulder, directly below the clavicle.
- L (left arm) electrode: near the left shoulder, directly below the clavicle.
- F (left leg) electrode: on the left hypogastrium.

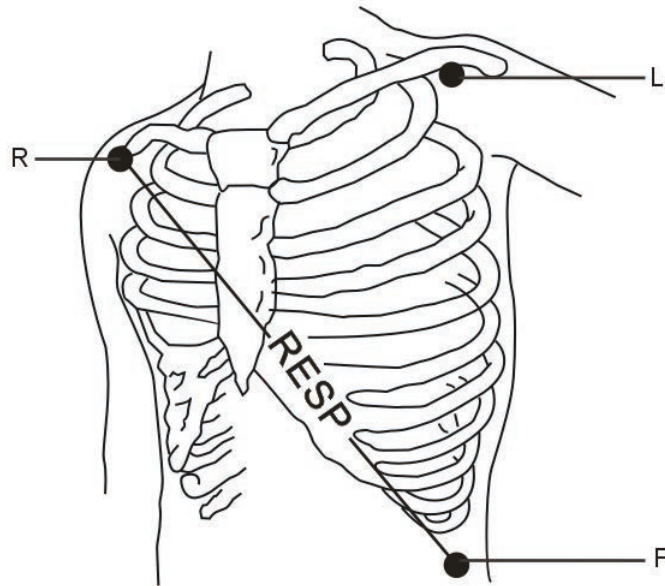


Figure 10-1 Positions of 3-Leadwire Electrode Placement

The chart below shows the label used to identify each leadwire. Included also is its associated color code per American (AHA) and European (IEC) standards.

American Standard		European Standard	
Label	Color	Label	Color
RA	White	R	Red
LA	Black	L	Yellow
LL	Red	F	Green

5-Leadwire Electrode Placement

Following is the configuration per American standard when using five leadwires:

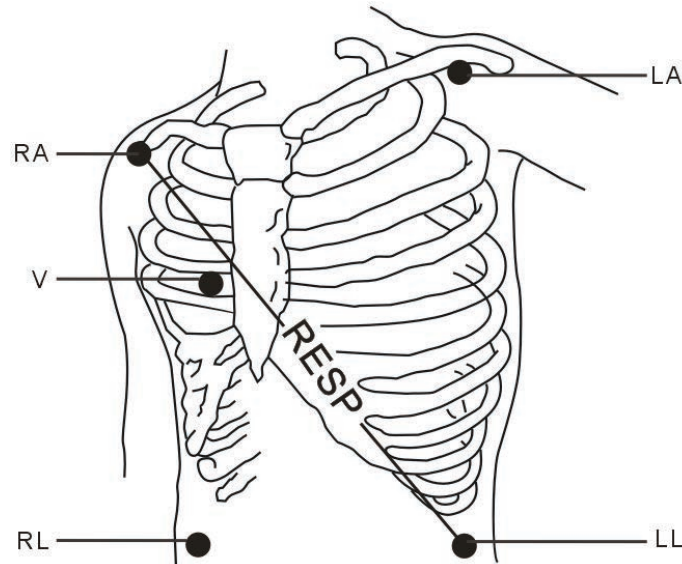


Figure 10-2 5-Leadwire Electrode Placement

- RA (right arm) electrode: near the right shoulder, directly below the clavicle.
- LA (left arm) electrode: near the left shoulder, directly below the clavicle.
- RL (right leg) electrode: on the right hypogastrium.
- LL (left leg) electrode: on the left hypogastrium.
- V (precordial) electrode: on the chest.

Attach the chest (V) electrode to one of the following positions indicated in *Figure 10-3*:

- V1: On the 4th intercostal space at the right sterna margin.
- V2: On the 4th intercostal space at the left sterna margin.
- V3: Midway between V2 and V4 electrodes.
- V4: On the 5th intercostal space at the left clavicular line.
- V5: On the left anterior axillary line, horizontal with V4 electrode.
- V6: On the left middle axillary line, horizontal with V4 electrode.
- V3R-V7R: On the right side of the chest in positions corresponding to those on the left.
- VE: Over the xiphoid.

When attaching the chest electrode to the back of a patient, place it at one the following sites:

- V7: On the 5th intercostal space at the left posterior axillary line of the back.
- V7R: On the 5th intercostal space at the right posterior axillary line of the back.

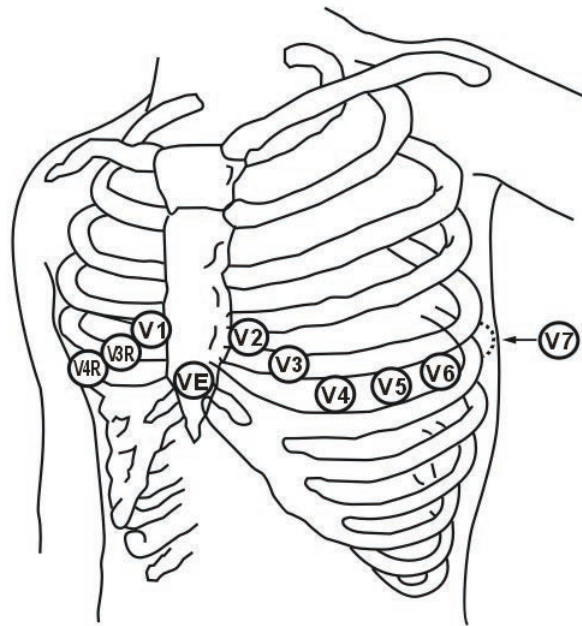


Figure 10-3 Positions of Chest Electrode

The chart below shows the label used to identify each leadwire. Included also is its associated color code per American (AHA) and European (IEC) standards.

American Standard		European Standard	
Label	Color	Label	Color
RA	White	R	Red
LA	Black	L	Yellow
LL	Red	F	Green
RL	Green	N	Black
V	Brown	C	White

10-Leadwire Electrode Placement

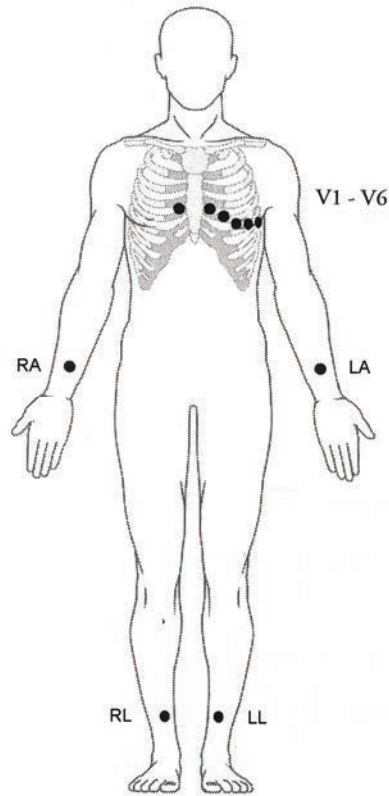


Figure 10-4 10-Leadwire Electrode Placement

12-lead ECG monitoring uses 10 electrodes which are placed on the patient's four limbs and chest. The limb electrodes should be placed on the soft skin and the chest electrodes placed according to the physician's preference.

Electrode Placement for Surgical Patients

Electrode placement during surgery is dependent on the type of surgery being performed. For example, with open chest surgery, the electrodes might be placed laterally on the chest or on the back. In the operating room, artifact can sometimes affect the ECG waveform due to the use of electrosurgery equipment. To help reduce this, place the electrodes on the right and left shoulders, the right and left sides near the stomach, and place the chest lead on the left side at mid-chest. Avoid placing the electrodes on the upper arms. This will cause the ECG waveform to be too small.

⚠ WARNING

- When using Electrosurgery equipment, patient leads should be placed in a position that is equal distance from the Electrosurgery electrotome and the grounding plate to avoid burns to the patient. The Electrosurgery equipment wire and the ECG cable must be kept separated and not allowed to tangle.
 - When using Electrosurgery equipment, never place the ECG electrodes near the grounding plate of the Electrosurgery device. This will cause a great deal of interference with the ECG signal.
-

10.2.3 Characteristics of Quality ECG Signal

As shown in *Figure 10-5*, the normal QRS complex should exhibit the following characteristics.

- Tall and narrow with no notches.
- With a tall R-wave completely above or below the baseline.
- With a pacer spike no higher than the height of the R-wave.
- With the T-wave less than one-third of the height of the R-wave.
- With the P-wave much smaller than the T-wave.

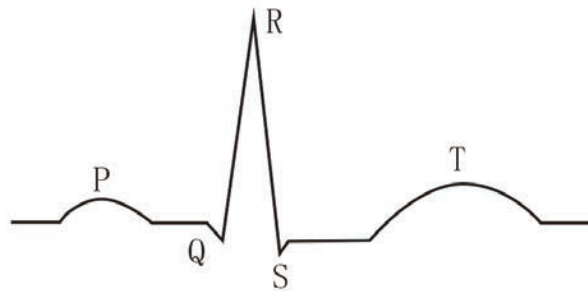


Figure 10-5 Standard ECG Waveform

To display a 1-millivolt calibration pulse on the ECG wave, select the ECG CAL option in the ECG SETUP menu. A message "when CAL, can't monitor!" is displayed on the screen.

NOTE

- If the ECG waveform is too small, or not accurate, and the electrodes are secure and firmly attached to the patient, change the display to a different lead.
-

10.3 ECG Display

10.3.1 ECG Waveform

In the standard screen, one or two ECG waveform(s) is (are) displayed at the top of the display when LEAD TYPE is set to 3 LEADS or 5LEADS respectively in the ECG SETUP menu.

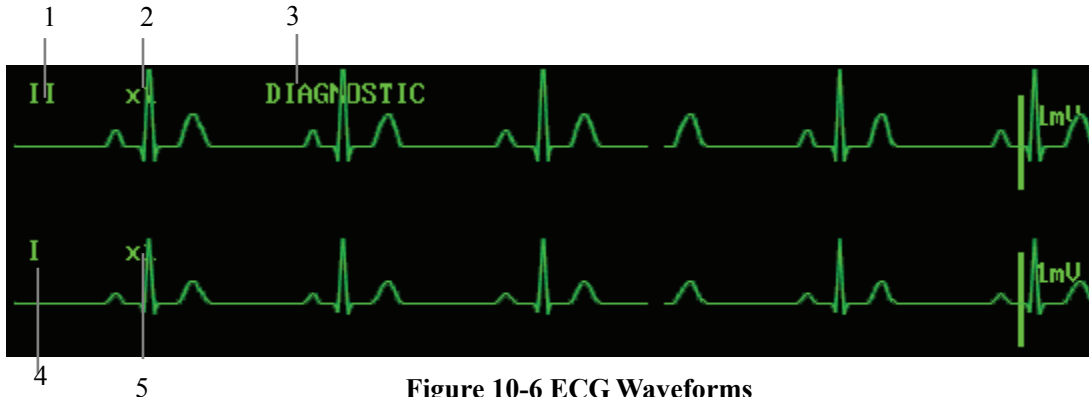


Figure 10-6 ECG Waveforms

As shown above, when 5 LEADS is selected, five labels are located above the ECG waveforms:

1. ECG lead of channel 1 (Primary lead)

You can select the lead of channel 1 from the label options.

- ◆ When you use a 3-lead set, the monitor gives three lead options: I, II and III;
- ◆ When you use a 5-lead set, the monitor gives seven lead options: II, III, aVR, aVL, aVF, V and I.

2. Gain of the channel-1 waveform

You may use this label to adjust the amplitude of the channel-1 ECG waveform. The gain options include $\times 0.125$, $\times 0.25$, $\times 0.5$, $\times 1$, $\times 2$ and AUTO. When AUTO is selected, the monitor adjusts the gain automatically. Besides, a 1mV scale is displayed at the right side of each ECG waveform. The height of the 1mV bar is directly proportional to the ECG waveform amplitude.

3. Filter Method

The filtering enables clearer and more detailed waveforms. There are three filter methods for selection.

- ◆ DIAGNOSTIC: The monitor displays the ECG waveforms without filter;
- ◆ MONITOR: It effectively filters the artifacts that might cause false alarms;

- ◆ SURGERY: This filter is used to reduce the artifacts and interference from electrosurgery equipment.

The selected filter is applied to both channels, but the filter label is merely displayed above the first ECG waveform.

WARNING

- **Only in the DIAGNOSTIC mode will the monitor provide non-processed real signal waveforms. In the MONITOR or SURGERY mode, the ECG waveforms may have slight distortions and the result of the ST segment analysis may be affected greatly. In the SURGERY mode, the ARR analysis result may be affected to some extent. Hence, the DIAGNOSTIC mode is recommended when monitoring a patient in an environment with slight interference.**
-
-

4. ECG lead of channel 2 (Secondary lead)
You can select the lead of channel 2 in the same method used to select the channel-1 lead.
5. Gain of the channel-2 waveform
You can adjust the gain of the channel-2 ECG waveform in the same method used for channel 1.

Besides, pace pulse marks “|” are shown above the ECG wave if the PACE is set to ON and the patient has a paced signal. If a defibrillator is connected, the synchronization marks are shown on the ECG wave.

NOTE

- **If the amplitude of an ECG waveform is too large, the peak of the waveform might not be displayed. In this case, you should change the waveform gain properly.**
 - **The selected leads of channel 1 and channel 2 should not be identical. Otherwise, the system will change one of them automatically. In the MULTI-LEADS DISPLAY mode or the HALF-SCN MUTLI-LEADS display mode, the leads of both channels cannot be set.**
-

10.3.2 ECG Parameters



Figure 10-7 ECG Parameters

The parameters related to ECG are displayed to the right of the ECG waveforms as shown above. The heartbeat indicator flashes in the same rate with the patient’s heartbeat or pulse. The status of PACE, ST1, ST2, PVCs and NOTCH is shown at the right side of HR/PR reading.

If your monitor is not configured with ST and ARR features, the numerics of ST1, ST2 and PVCs will not be displayed.

10.4 ECG Setup Menu

To display the ECG SETUP menu, use the knob to select the ECG label in the parameter windows. The options available in the menu vary with each algorithm package


ECG SETUP			
HR ALM	ON	LEAD TYPE	5 LEADS
ALM LEV	MED	SWEEP	25.0
ALM REC	OFF	ECG DISPLAY	
ALM HI	120	NORMAL DISPLAY	
ALM LO	55		
HR FROM	ECG		
HR CHANNEL	CH1	OTHER SETUP >>	
Back to the upper menu.			
EXIT			

Figure 10-8 ECG SETUP Menu (Mindray DS Algorithm Package)

ECG SETUP			
HR ALM	ON	LEAD TYPE	5 LEADS
ALM LEV	MED	ECG DISPLAY	
ALM REC	OFF	NORMAL DISPLAY	
ALM HI	120	ST ANALYSIS >>	
ALM LO	50	ARR ANALYSIS >>	
HR FROM	BOTH	OTHER SETUP >>	
SWEEP	25.0		
Access the sub-menu of Manual ST Analysis Setup.			
EXIT			

Figure 10-9 ECG SETUP Menu (Mortara Algorithm Package)

The options of ECG SETUP menu are listed below. However, your algorithm package may not include some of these options.

- HR ALM Heart rate alarm on/off status
 ON: When a heart rate alarm occurs, the monitor gives alarm indications and stores the alarm;
 OFF: When a heart rate alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
 When OFF is selected, the  icon is displayed on the right of the ECG label.
- ALM LEV Alarm level
 Options: HIGH, MED and LOW.
- ALM REC Alarm recording
 ON: When a heart rate alarm occurs, the monitor enables the recording;
 OFF: When a heart rate alarm occurs, the monitor does not enable the recording.
- ALM HI Upper alarm limit
 Determines the upper ECG alarm limit.
- ALM LO Lower alarm limit
 Determines the lower ECG alarm limit.

For different patient types, the upper/lower limits of the heart rate alarm may vary in the following range.

Patient type	Upper Limit	Lower Limit	Increment (beat/min)
Adult	(lower limit+2)~300	15~(upper limit-2)	1
Pediatric	(lower limit+2)~350	15~(upper limit-2)	1
Neonate	(lower limit+2)~350	15~(upper limit-2)	1

NOTE

- Always set the alarm limits according to the clinical condition of the individual patient.
- In many cases, the upper limit of heart rate alarms should not exceed 20 beats per minute higher than the patient's heart rate.

- HR FROM Heart rate source
 Options: ECG, SPO2, IBP, AUTO and ALL

-
1. ECG: HR is always calculated from ECG.
 2. SpO₂: If the ECG signal is seriously interfered, you can select SPO2, which means PR will be derived from PLETH waveform. In this case, PULSE is displayed to the right of the ECG label while the PR reading is displayed below. The monitor activates pulse beeps instead of heartbeat beeps.
 3. IBP: If the ECG signal is seriously interfered, you can select IBP which means PR will be calculated by IBP module. In this case, PULSE is displayed to the right of the ECG label while the PR reading is displayed below. The monitor activates pulse beeps from IBP module.
 4. AUTO: The monitor determines the heart rate source depending on the signal quality. The priorities for heart rate calculation are: ECG, SpO₂, IBP.
 5. ALL: The monitor displays both the HR and the PR values. PR value is displayed at the right of SpO₂ label or IBP label, SpO₂ takes priority of IBP. The monitor will alarm for both abnormal HR and PR. HR is given priority in determining the source of the beep tone. If HR is not available, the sound will be from the PR.

- HR CHANNEL
 - CH1: The heart rate is determined by the first ECG waveform;
 - CH2: The heart rate is determined by the second ECG waveform;
 - AUTO: The monitor automatically selects an optimal channel to calculate the heart rate.

This option is available in Mindray DS algorithm package only. For Mortara algorithm package, the monitor uses both channels to calculate the heart rate simultaneously.

- LEAD TYPE Options: 3 LEADS, 5 LEADS and 12LEADS;
- SWEEP Options: 12.5, 25.0 and 50.0 mm/s;
- ECG DISPLAY

When LEAD TYPE is set to 5 LEADS, you can select one of the following options:

1. NORMAL DISPLAY: The monitor displays two ECG waveforms.
2. MULTI-LEADS DISPLAY: The monitor displays six ECG waveforms, which occupies the whole waveforms area.
3. HALF-SCN MULTI-LEADS: The monitor displays six ECG waveforms, which only occupies four waveform positions.

When LEAD TYPE is set to 3 LEADS, only NORMAL DISPLAY can be selected for the ECG DISPLAY. When LEAD TYPE is set to 12LEADS, you can select 12-LEAD DISPLAY to enter the 12-lead monitoring display.

Other Setup

Select OTHER SETUP >> in the ECG SETUP menu. The following menu appears. The options available in the menu vary with each algorithm package.

ECG SETUP	
SMART LEAD OFF	OFF ▾ DEFIB SYNC OFF ▾
BEAT VOL	2 ⇅ ECG CAL
PACE	OFF ▾ ADJUST WAVE POS >>
NOTCH	OFF ▾ CONFIG >>
CASCADE	OFF ▾
Back to the upper menu.	
EXIT	

Figure 10-10 Other ECG Setup (Mindray DS Algorithm Package)

ECG SETUP	
SMART LEAD OFF	OFF ▾ CASCADE OFF ▾
BEAT VOL	2 ⇅ DEFIB SYNC OFF ▾
PACE	OFF ▾ 12-LEAD RECALL >>
PACE LEAD	II ▾ ECG CAL
PACER RATE	--- ⇅ ADJUST WAVE POS >>
NOTCH	OFF ▾ CONFIG >>
Back to the upper menu.	
EXIT	

Figure 10-11 Other ECG Setup (Mortara Algorithm Package)

In this menu, you can select any of the displayed option. All options are listed below. Your algorithm package may not include some of these options.

- SMART LEAD OFF**
 - ON: If there is a LEAD OFF in the HR-derived channel, the system will automatically switch to another lead to restore the display of the ECG waveform in the HR-derived channel.
 - OFF: The SMART LEAD OFF is turned off.

When ECG is in NORMAL DISPLAY mode, if the SMART LEAD OFF is configured ON and there is a LEAD OFF in the HR-derived channel, the system will automatically switch to another lead to restore the display of the ECG waveform in the HR-derived channel. When the LEAD OFF condition is corrected, the leads are automatically switched back. However, if you manually switch the HR-derived channel, change the ECG display mode, or turn off SMART LEAD OFF before the LEAD OFF condition is corrected, the leads will not be switched back.

Switching rules for SMART LEAD OFF:

LEAD OFF condition	HR-derived channel automatically switches to
RA OFF	III
LL OFF	I
LA OFF	II
V OFF	II
RL OFF	None
Any two out of LL, RA and LA fall off.	None
LL, RA or LA, and V fall off together	Same as LL, RA or LA falls off.

NOTE

-
- **The SMART LEAD OFF function is available only when the LEAD TYPE is 5 LEADS or 12 LEADS.**
 - **When the HR CHANNEL is set to AUTO, SMART LEAD OFF does not work as long as there is ECG waveform displayed in either channel 1 or 2.**
 - **When you perform ECG calibration, SMART LEAD OFF does not work.**
-

- **BEAT VOL** Beat volume
Range: 0-10. 0 indicates disabled and 10 indicates the maximum volume.
- **PACE** ON: When ON is selected, a detected pacemaker signal is indicated by a "|" symbol above the ECG waveform.
OFF: When OFF is selected, the pacemaker analysis is disabled.

NOTE

- **When monitoring a patient with a pacemaker, PACE must be turned ON. Otherwise, the system will count the pacemaker pulse as QRS complex. Do not completely depend on the alarms of heart rate. The patient with a pacemaker must be nearly monitored.**
 - **When PACE is turned ON, the system will neither detect the arrhythmia relating to premature ventricular beats (including PVCs counting) nor perform the ST analysis. When monitoring a patient without a pacemaker, PACE should be turned OFF.**
 - **The PACE tag can be printed in the real-time recording when PACE is turned ON.**
-

- **PACE LEAD** Set PACE LEAD as required.

NOTE

- **You can switch the leads by setting LEAD TYPE in the ECG SETUP menu. At the time of switching between 5 LEADS and 3 LEADS, PACE LEAD in the ECG SETUP menu will be II.**
-

- **PACER RATE** Some pace pulses may be difficult to suppress. When this happens, the pace pulse may be counted as a QRS complex, and could result in incorrect HR measurements and failure to detect some arrhythmias. This option allows you to input the heart rate of pacemaker, so that the software can calculate the HR and detect the arrhythmias more accurately. When PACE is set to OFF, this option is disabled.
- **NOTCH** Determines whether filter or not.
ON: The monitor protects the signals from the noise generated by the power line.
OFF: No filtering.

NOTE

- **If the filter method of the ECG waveform is set to a non-diagnostic mode, only the NOTCH option ON is active and the monitor filters the signals of the power line frequency.**
-

- **CASCADE** ECG cascade
ON: The monitor displays the waveform of each channel in two lines.
OFF: The monitor displays the waveform of each channel in one line.
The CASCADE can be turned ON only if the monitor is set to NORMAL DISPLAY mode and the SCAN TYPE is set to REFRESH.
- **DEFIB SYNC** Defibrillator synchronization
ON: The function of defibrillation is enabled;
OFF: The function of defibrillation is disabled.

If the function of defibrillator synchronization is enabled and the ventricular defibrillation is applied, 100ms/+5V defibrillator synchronization signals will be output through the auxiliary output connector to the defibrillation equipment.

When the defibrillator synchronization is enabled, the “Defib Sync ON!” message is displayed in the prompt information area, at the lower left corner of the screen. This message disappears after 10 seconds. Besides, the technical alarms area also shows the “DEFIB SYNC ON” message.

NOTE

- **Defibrillator synchronization can be enabled only if the AUX OUTPUT in the USER MAINTAIN menu is set to DEFIB. SYN. Otherwise, this function is disabled.**
 - **When the monitor is started, DEFIB SYNC is set to OFF as a default.**
-

WARNING

- **Improper defibrillation will endanger the patient’s safety. You user should decide whether to defibrillate the patient based on the patient’s actual condition.**
 - **Before defibrillating the patient, the user should ensure the defibrillator and the monitor have been tested as a system and the two devices can work together safely and effectively.**
 - **Before defibrillating the patient, the user should ensure the defibrillator has been connected to the auxiliary output port of the monitor, the defibrillation synchronization function is enabled, and the filter mode is set to DIAGNOSTIC.**
 - **When the defibrillation is done, sure to disable the defibrillation function and select the filter method as needed.**
-

-
- ECG CAL Select this option to begin calibrating the ECG. To stop calibration, select this option again, or change the ECG lead selection on the screen.
 - ADJUST WAVE POS >> This is used to adjust the position of the ECG waveform on the screen. Select this option to access the ADJUST WAVE POS menu. Open the CH NAME popup menu and select the channel to be adjusted. Afterwards, select the UP-DOWN option and rotate the control knob to adjust the position of the selected channel on the screen. The BACK TO DEFAULT option allows you to restore the waveform to the default position on the screen.

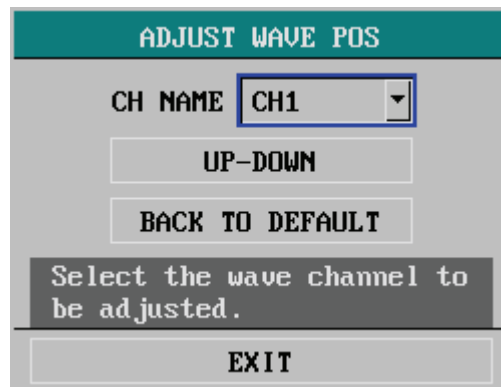


Figure 10-12 ADJUST WAVE POS Menu

- CONFIG >> You can use this option to access the ECG CONFIG menu. You may choose the FACTORY CONFIG or the USER CONFIG. After finishing the selection, a dialog pops up asking for confirmation of your selection.

10.5 ST Analysis

10.5.1 Overview

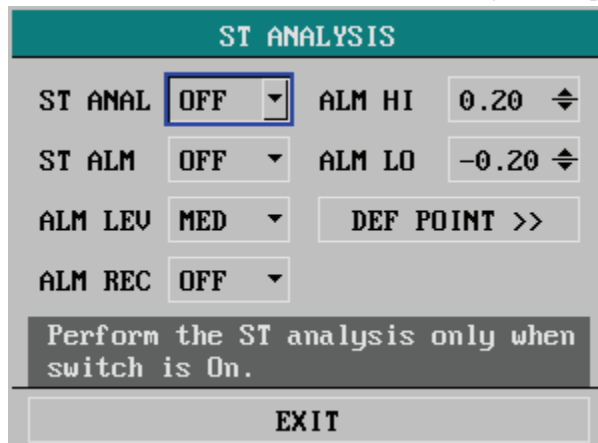
- The function of ST analysis is optional.
- In the factory configuration, ST analysis is disabled.
- When turning ST ANALYSIS on, the monitor selects DIAGNOSTIC mode automatically. You can set the monitor to MONITOR or SURGERY mode as required. However, ST analysis will turn off automatically.
- With the ST analysis, the variance of the ST segment at the waveform tracks of the selected lead can be measured. The ST measurement result is displayed numerically in the ST1 and ST2 positions in the parameter window.
- You can review the ST trend graph and trend data in the TREND GRAPH and the TREND TABLE menus.
- Measurement unit of the ST segment: mV (millivolt).
- Measurement symbols of the ST segment: “+” means positive elevation, “-” means negative elevation.
- Measurement range of the ST segment: -2.0 mV to +2.0 mV.

WARNING

- ST analysis is not intended for neonatal patients.
 - The ST algorithm has been tested for accuracy of the ST segment data. The significance of the ST segment changes need to be determined by a clinician.
-

10.5.2 3/5-Lead ST Analysis Menu

Select ST ANALYSIS >> in ECG SETUP menu. The following menu appears.



ST ANALYSIS			
ST ANAL	OFF	ALM HI	0.20
ST ALM	OFF	ALM LO	-0.20
ALM LEV	MED	DEF POINT >>	
ALM REC	OFF		
Perform the ST analysis only when switch is On.			
EXIT			

Figure 10-13 ST Analysis


In this menu, you can perform the following settings:

-
- ST ANAL ST analysis
ON: Enables the ST analysis;
OFF: Disables the ST analysis.

NOTE

- **ST analysis can be carried out only when the filter method is set to DIAGNOSTIC. When ST analysis is switched on, the filter method will automatically switch to DIAGNOSTIC if it is not in the diagnostic mode. However, if you switch the filter method to MONITOR or SURGERY, ST analysis will turn off automatically. In case that you change MONITOR or SURGERY to DIAGNOSTIC and ST analysis keeps off, you can turn it on manually.**
 - **When ST analysis is switched on, the notch filter is switched on automatically. However, you can manually switch NOTCH off as necessary.**
-

- ST ALM ST segment alarm
ON: If the measured ST numerics exceed the alarm limit, the monitor gives alarm indications and saves the alarm;
OFF: If the measured ST numerics exceed the alarm limit, the monitor does not give alarm indications or saves the alarm.

When OFF is selected, the  icon is displayed on the right of ST1 in the parameter window.
- ST ALM ST alarm level
Options: HIGH, MED and LOW;
- ALM REC ST alarm recording
ON: The monitor starts recording when an ST alarm occurs;
OFF: The monitor does not record when an ST alarm occurs.
- ALM HI Determines the upper limit of the ST alarm; 2.0mV is the highest.
- ALM LO Determines the lower limit of the ST alarm; -2.0 mV is the lowest.

NOTE

- **The alarm limits for two ST segment numerics are identical. You cannot set the alarm limit of one channel separately.**
-

10.5.3 Adjusting ST Measurement Point

The ST measurement for each beat complex is the vertical difference between two measurement points. The isoelectric point provides the baseline for the measurement and the ST point provides the other measurement point.

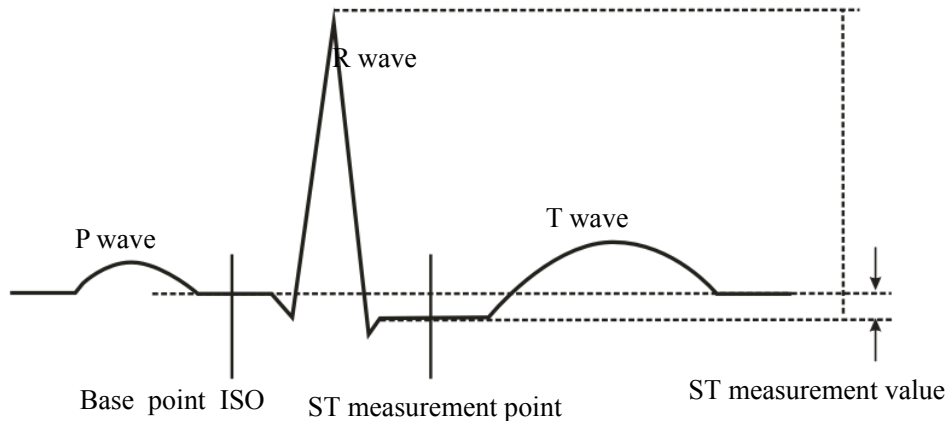


Figure 10-14 ST Measurement Point

The ST measurement points need to be adjusted when you start monitoring, and if the patient's heart rate or ECG morphology changes significantly. Artifactual ST segment depression or elevation may occur if the ISO or the ST point is incorrectly set.

NOTE

-
- **Abnormal QRS complex is not considered in ST analysis.**
-

Mortara algorithm package

To adjust the points:

1. Select DEF POINT >> in the ST ANALYSIS menu to open the following window. Three vertical cursors indicate the positions of the ISO, J and ST points.

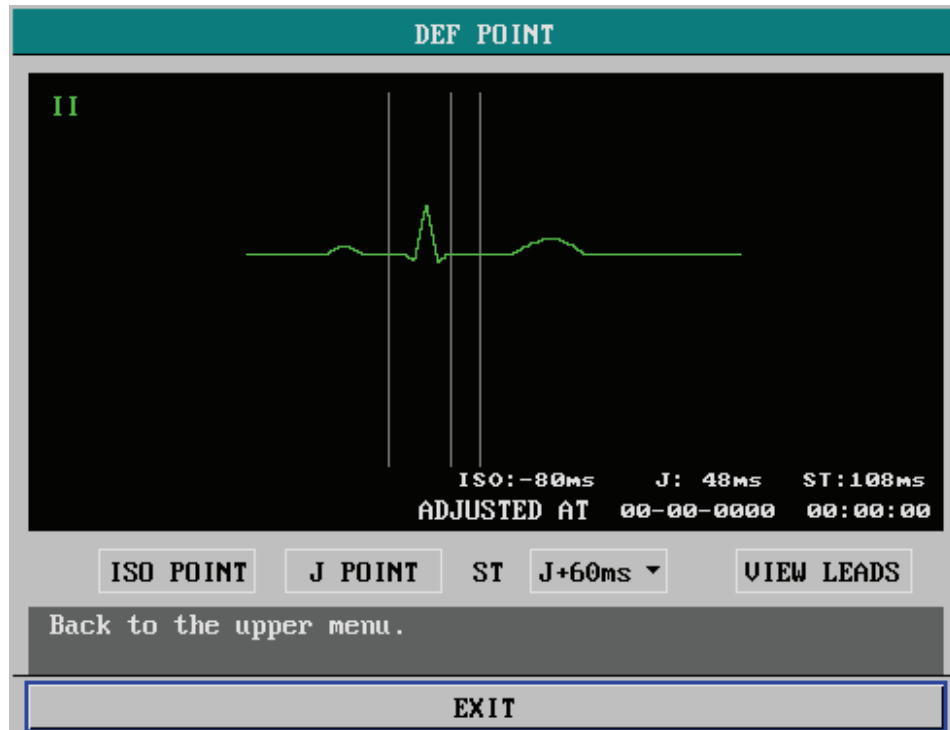


Figure 10-15 ST Measurement Point

2. Select VIEW LEADS option, and then rotate the knob to select a suitable ECG lead for ST measurement, with a visible J-point and a visible P wave.
3. Select ISO, J or ST option, and then rotate the knob to adjust the position of each point respectively.
 - ◆ The ISO-point cursor positions the isoelectric point relative to the R-wave peak. Position the ISO-point in the middle of the flattest part of the baseline (between the P and Q waves or in front of the P wave).
 - ◆ The J-point cursor positions the J-point relative to the R-wave peak. It helps to correctly position the ST-point. Position the J-point at the end of the QRS complex and the beginning of the ST segment.
 - ◆ The ST-point is positioned a fixed distance from the J-point, either J+60 or J+80. Move the J-point cursor to position the ST-point at the midpoint of the ST segment.

10.6 Arrhythmia Analysis

10.6.1 Overview

The monitor uses the user-selected primary or secondary ECG lead for arrhythmia analysis. In clinical application, the medical professionals can use the arrhythmia analysis to evaluate patients' condition (such as heart rate, PVCs rate, rhythm and ectopic beat) and give proper treatment.

The arrhythmia analysis of the monitor has the following characteristics:

- Applicable to the monitoring of a patient either with a pacemaker or without a pacemaker.
- Disabled in the factory configuration.
- Capability of raising the doctor's attention to the patient's heart rate, by measuring and classifying the arrhythmia and the abnormal heartbeat and triggering the alarm.
- Capability of storing the latest 80 alarm events (including the ECG waveform respectively 4 seconds before and after the alarm), when performing the arrhythmia analysis. You can review the arrhythmia events through the menu below.

WARNING

- **The arrhythmia analysis program is intended to detect ventricular arrhythmias. It is not intended to detect atrial or supraventricular arrhythmias. Occasionally it may incorrectly identify the presence or absence of an arrhythmia. Therefore a physician must analyze the arrhythmia information in conjunction with more clinical findings.**
 - **The arrhythmia detection is not intended for neonatal patients.**
-

10.6.2 Arrhythmia Options

Mortara algorithm package

When Mortara algorithm package is configured, your monitor has the following extended arrhythmia analysis option.

Arrhythmia Message	Description
ASYSTOLE	No QRS complex within the defined time in absence of ventricular fibrillation or chaotic signals.
VFIB	Ventricular fibrillation occurs and persists for 6 seconds.
VTAC	Ventricular HR is greater or equal to the defined limit and the number of consecutive PVCs is greater than the defined value.
PNP	No pace pulse within $(60 * 1000 / \text{pace rate} + 90)$ milliseconds following a QRS complex or a pacer pulse (for paced patient only).
PNC	No QRS complex within 300 milliseconds following a pace pulse (for paced patient only).
V RHYTHM	Ventricular HR is less than the defined limit and the number of PVCs is greater than 3.
COUPLET	Pair PVCs are detected.
VT > 2	Ventricular HR is greater than or equal to the defined limit and the number of PVCs is greater than or equal to 3 but less than the defined limit.
BIGEMINY	A dominant rhythm of N, V,N, V, N, V.
TRIGEMINY	A dominant rhythm of N, N, V,N, N, V, N, N, V.
R ON T	R on T is detected.
MULTIF. PVC	More than two forms of PVCs are detected within the defined search window (3 to 31).
IRR. RHYTHM	Consistently irregular rhythm
MISSED BEATS	No beat detected for 1.75x average R-R interval for HR <120, or No beat for 1 second with HR >120 (non-paced patient only), or No beat detected for more than the set pause threshold.
BRADY	The HR is less than or equal to the defined bradycardia low limit.
TACHY	The HR is greater than or equal to the defined tachycardia high limit.

10.6.3 Arrhythmia Analysis Menu

Select ARR ANALYSIS >> in ECG SETUP menu. The following menu appears. The menu items vary with the algorithm packages.

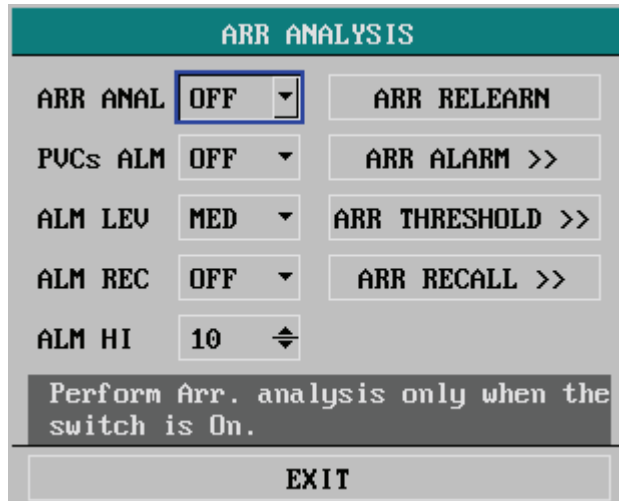



Figure 10-16 Arrhythmia Analysis (Mortara algorithm package)

In this menu, you can perform the following settings:

- ARR ANAL Arrhythmia analysis
ON: Enables the arrhythmia analysis;
OFF: Disables the arrhythmia analysis.
- PVCs ALM PVCs alarm
ON: When the PVCs alarm occurs, the monitor gives alarm indications and saves the alarm;
OFF: When the PVCs alarm occurs, the monitor neither gives alarm indications nor saves the alarm;
When OFF is selected, the  icon is displayed on the right of PVCs in the parameter window.
- ALM LEV Alarm level
Options: HIGH, MED and LOW.
- ALM REC Alarm recording
ON: The monitor starts recording when the PVCs alarm occurs.
OFF: The monitor does not record when the PVCs alarm occurs.
- ALM HI Upper alarm limit
Determines the upper limit of the PVCs alarm. Range: 1 - 10.
An alarm is triggered when the PVCs exceeds the upper limit.

10.6.4 Arrhythmia Relearn

During ECG monitoring, you may need to start an arrhythmia relearn when a dramatic change in the patient's ECG pattern has occurred. A change in the ECG pattern could result in:

- Incorrect arrhythmia alarms,
- Loss of ST measurements, and/or
- Inaccurate heart rate.

Arrhythmia relearn allows the monitor to learn the new ECG pattern to correct arrhythmia alarms and heart rate value, and to restore ST measurements. To manually start an arrhythmia relearn, select the ARR RELEARN option in the ARR ANALYSIS menu. The "ARR LEARNING" message will be displayed in the information area.

10.6.5 Arrhythmia Alarm Setup

Select ARR ALARM >> in the ECG SETUP menu. The following menu appears.

ARR ALARM				
	ALM	LEU	REC	
ASYSTOLE	ON	HIGH	OFF ▾	ALL ALM ON
VFIB	ON	HIGH	OFF ▾	ALL ALM OFF
VTAC	ON	HIGH	OFF ▾	ALL REC ON
R ON T	ON ▾	MED ▾	OFF ▾	ALL REC OFF
VT>2	ON ▾	MED ▾	OFF ▾	ALM LEU
COUPLET	ON ▾	MED ▾	OFF ▾	MED ▾
MULTIF. PVC	ON ▾	MED ▾	OFF ▾	
VENT RHYTHM	ON ▾	MED ▾	OFF ▾	UP-DOWN
When the ASYSTOLE is alarming, start up the recorder to record the alarm event or not.				
EXIT				

ARR ALARM				
	ALM	LEV	REC	
BIGEMINY	ON	MED	OFF	ALL ALM ON
TRIGEMINY	ON	MED	OFF	ALL ALM OFF
TACHY	ON	MED	OFF	ALL REC ON
BRADY	ON	MED	OFF	ALL REC OFF
IRREG RHYTHM	ON	MED	OFF	ALM LEV
PNC	ON	MED	OFF	MED
PNP	ON	MED	OFF	
MISSED BEATS	ON	MED	OFF	UP-DOWN

Open or close the BIGEMINY alarm.

EXIT

Figure 10-17 Arrhythmia Alarm Setup (Mortara algorithm package)

In the menu, the ALM field indicates the alarm on/off status, REC indicates the alarm recording on/off status and LEV indicates the alarm level. You can change the settings as described below.

- ALL ALM ON All alarms on
Enables all arrhythmia alarms;
- ALL ALM OFF All alarms off
Disables all arrhythmia alarms that can be disabled;
- ALL REC ON All recording on
Enables the recording of all arrhythmia alarms;
- ALL REC OFF All recording off
Disables the recording of all arrhythmia alarms;
- ALM LEV Options: HIGH, MED and LOW.
Sets the level of all arrhythmia alarms that can be set to the same value.
- UP-DOWN Page up or down

10.6.6 Arr Threshold

Select ARR THRESHOLD >> in the ECG SETUP menu and the following menu appears. You can change the threshold settings in this menu. An alarm will be triggered when a rate exceeds a threshold.

ARR THRESHOLD	
ASYS DELAY	5 s
VTAC RATE	130 bpm
VTAC PVC	6 beats
MULTIF. PVC	15 beats
TACHY HI	100 bpm
BRADY LO	60 bpm
Set the asystole delay time.	
EXIT	

Figure 10-18 ARR Threshold Setup

ARR Event	Range	Default	Step	Unit
ASYS DELAY	3 to 10	5	1	s
VTAC RATE	100 to 200	130	5	bpm
VTAC PVC	3 to 12	6	1	Beats
MULTIF. PVC	3 to 31	15	1	Beats
TACHY HI	Adult: 100 to 300 Pediatric: 160 to 300	Adult: 100 Pediatric: 160	5	bpm
BRADY LO	Adult: 15 to 60 Pediatric: 15 to 80	Adult: 60 Pediatric: 80	5	bpm

10.6.7 Arrhythmia Recall

Select ARR RECALL >> in the ARR ANALYSIS menu. The following menu appears. You can review any stored arrhythmia event in this menu.

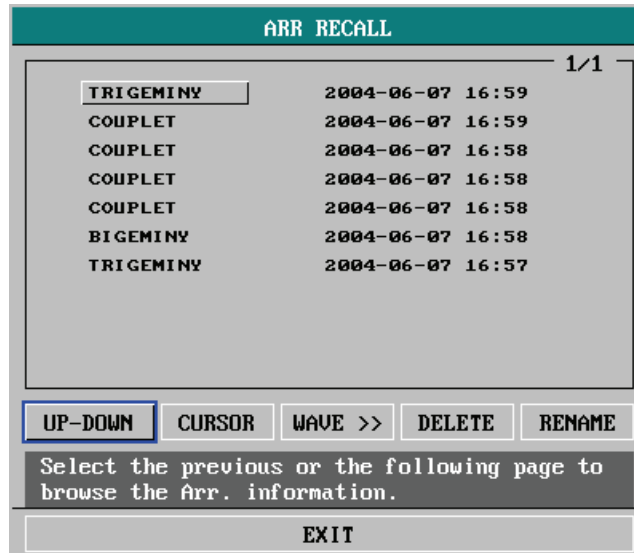


Figure 10-19 Arrhythmia Recall

You can perform the following operations:

- UP-DOWN A maximum of 10 arrhythmia events can be displayed in the window each time. In case of more than 10 events, you can use the UP-DOWN option to review more. At most 8 pages can be reviewed.
- CURSOR This option allows you to select an arrhythmia event displayed in the window.
- DELETE This option allows you to delete a selected arrhythmia event.
- RENAME This option allows you to change the name of a selected arrhythmia event.
Select this option, and rotate the control knob till the desired name appears. Then, press the control knob to select the name.
- WAVE >> Selecting this option opens the following window. In the window, the waveform and the time of a selected arrhythmia event as well as the parameter values at the event time are displayed.

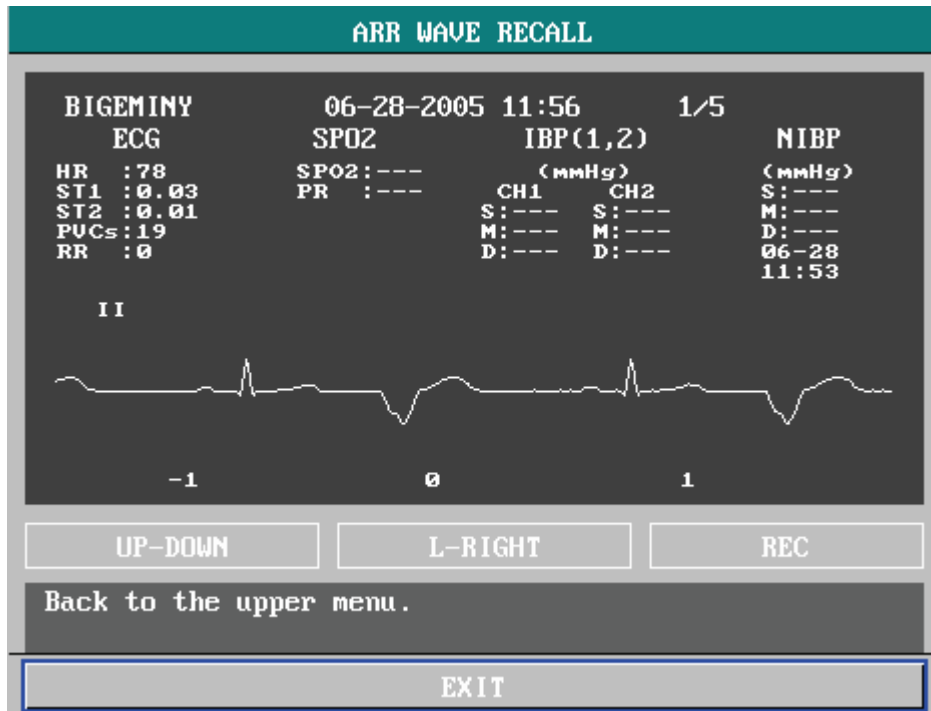


Figure 10-20 Arrhythmia waveform Review

You can perform the following operations:

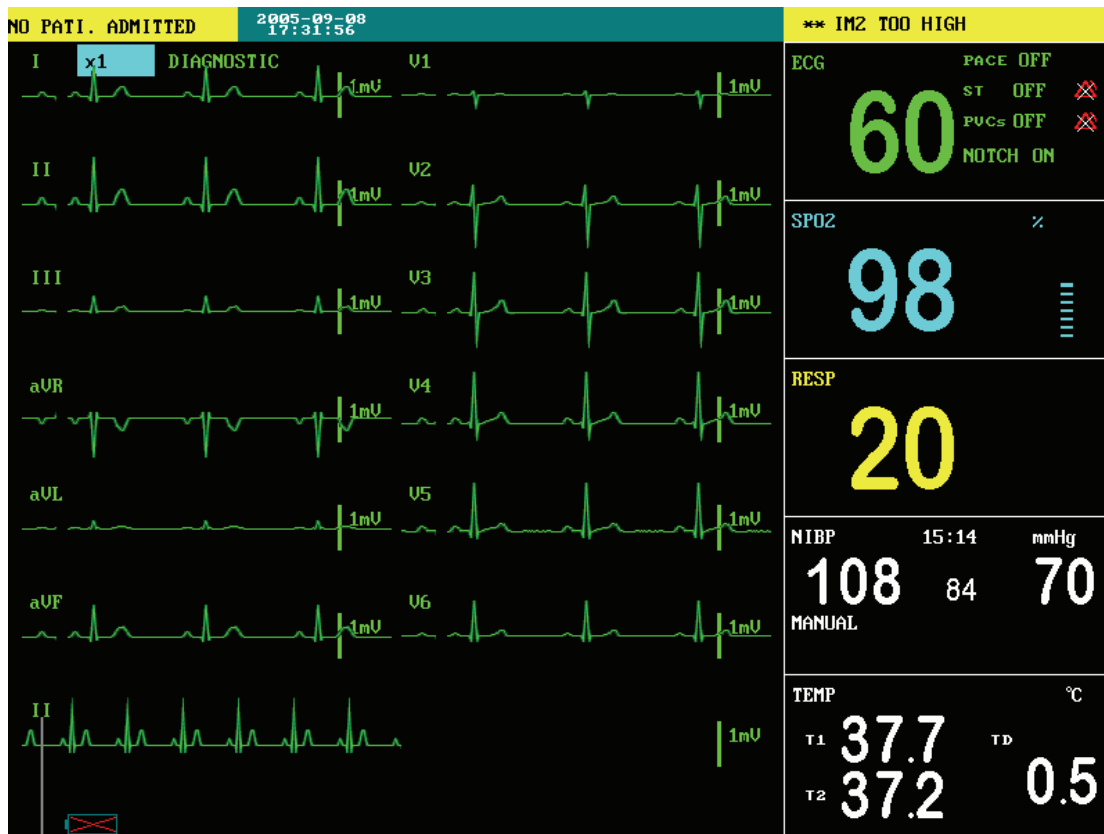
- **UP-DOWN** This option allows you to page up and down to review the waveform and the parameters of other arrhythmia events.
- **L-RIGHT** This option allows you to review 8-second waveform of the currently displayed arrhythmia event.
- **REC** Selecting this option starts the recording of the waveform and the parameters of the currently displayed arrhythmia event.
- **EXIT** This option allows you to return to the ARR RECALL window.

10.7 12-Lead

10.7.1 12-Lead Monitoring Display

You can enter the 12-lead monitoring display if your monitor is configured with the 12-lead monitoring. To enter the ECG 12-Lead monitoring screen:

1. Place the 10 electrodes on the patient.
2. Select the ECG label to enter the ECG SETUP menu.
3. Set LEAD TYPE to 12 LEADS.
4. Set the ECG DISPLAY to 12-LEAD DISPLAY.



Rhythm lead label

Figure 10-21 12-Lead Display

A total of 12 ECG waves and 1 rhythm wave will be displayed on the screen. The ST numerics are displayed in three groups:

- ANT (anterior): V1, V2, V3, V4
- INF(inferior): II, III, aVF, (aVR)
- LAT (lateral): I, aVL, V5, V6

Although aVR is displayed in the INF group, it is not an inferior lead.

In the 12-Lead Monitoring Display:

- Labels except the ECG-related ones (ECG, ST, GAIN, RHYTHM) are all disabled.
- The REC button on the control panel is disabled.
- You can press the MAIN and MENU buttons on the control panel to exit the 12-Lead Monitoring Display and return to the normal monitoring display.

10.7.2 12-lead ST Analysis Menu

Select the ST label in the parameter area, or select ST ANALYSIS >> in the ECG SETUP menu. The following menu appears.

The screenshot shows the 'ST ANALYSIS' menu with the following settings:

Parameter	Value	Parameter	Value
ST ANAL	ON	INF ALM HI	0.20
ST ALM	OFF	INF ALM LO	-0.20
ALM LEV	MED	LAT ALM HI	0.20
ALM REC	OFF	LAT ALM LO	-0.20
ANT ALM HI	0.20	DEF POINT >>	
ANT ALM LO	-0.20		

Perform the ST analysis only when switch is On.

EXIT


Figure 10-22 ST ANALYSIS menu

In the ST ANALYSIS menu, you can perform the following settings:

- ST ANAL ST analysis
 ON: Enables the ST analysis;
 OFF: Disables the ST analysis.

NOTE

- When ST ANAL is set to ON, the monitor selects **DIAGNOSTIC** mode automatically. You can set the monitor to **MONITOR** or **SURGERY** mode as required. However, ST analysis will turn off automatically.
-

-
- ST ALM ST segment alarm
ON: If the measured ST numerics exceed the alarm limit, the monitor gives alarm indications and saves the alarm;
OFF: If the measured ST numerics exceed the alarm limit, the monitor does not give alarm indications or save the alarm.
When OFF is selected, the  icon is displayed on the upper right of the ST data area.
 - ALM LEV ST alarm level
Options: HIGH, MED and LOW;
 - ALM REC ST alarm recording
ON: The monitor starts recording when an ST alarm occurs;
OFF: The monitor does not record when an ST alarm occurs.
 - ANT ALM HI Determines the upper limit of the ST alarm in the ANT group; 2.0mV is the highest.
 - ANT ALM LO Determines the lower limit of the ST alarm in the ANT group; -2.0 mV is the lowest.
 - INF ALM HI Determines the upper limit of the ST alarm in the INF group; 2.0mV is the highest.
 - INF ALM LO Determines the lower limit of the ST alarm in the INF group; -2.0 mV is the lowest.
 - LAT ALM HI Determines the upper limit of the ST alarm in the LAT group; 2.0mV is the highest.
 - LAT ALM LO Determines the lower limit of the ST alarm in the LAT group; -2.0 mV is the lowest.

10.8 RESP Monitoring

10.8.1 Overview

Respiration is detected by measuring thoracic impedance. The monitor measures the change of the impedance between the RA and LA electrodes of the ECG lead I, or the RA and LL electrodes of the ECG lead II, and produces a respiration waveform as shown below.

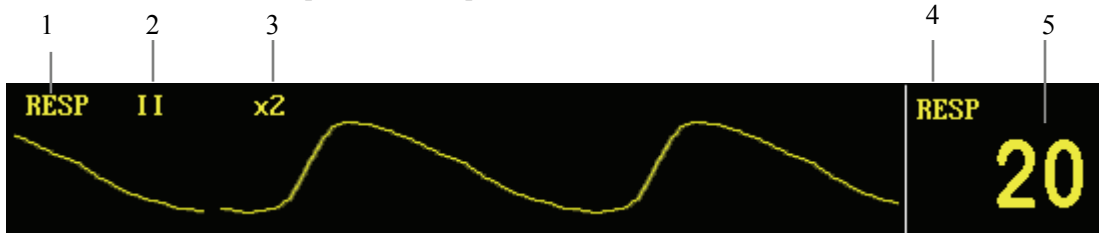


Figure 10-23 Respiration Waveform and Parameter

1. Waveform name.
2. RESP lead: I or II
3. Waveform gain: 7 options are available: $\times 0.25$, $\times 0.5$, $\times 1$, $\times 2$, $\times 3$, $\times 4$, $\times 5$. If the gain is too large, the upper part of the waveform may not be normally displayed.
4. RESP label: Selecting this label, you can open the RESP SETUP menu.
5. RR: Respiration rate numerics.

NOTE

- **Respiration monitoring is not recommended on patients who are very active, as this will cause false alarms.**
 - **It is recommended to set Waveform gain to 1 when external electromagnetic interference is great.**
-

10.8.2 Electrode Placement

Since the same electrodes are used for ECG and respiration monitoring, the electrode placement is very important. Some patients, due to their clinical condition, expand their chest laterally, causing a negative intrathoracic pressure. In these cases it is better to place the two electrodes used for respiration monitoring laterally in the right axillary and left lateral chest areas, at the maximum point of the breathing movement, to optimize the respiratory waveform.

NOTE

- To optimize the respiration waveform, place the RA and LA electrodes horizontally when the ECG Lead I is selected, and place the RA and LL electrodes diagonally when the ECG lead II is selected.
 - Try to avoid placing the electrodes so the liver area and the ventricles of the heart are in path between the electrodes used for respiration, to avoid cardiac artifact to overlay on the ECG. This is particularly important when monitoring neonate patients.
-

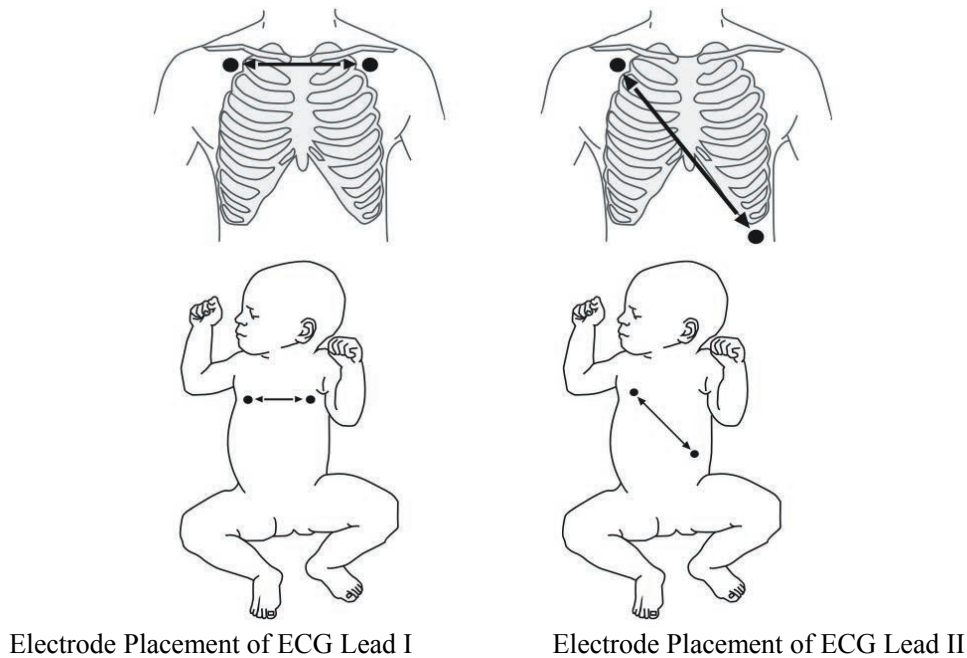


Figure 10-24 Electrode Placement


10.8.3 Respiration Setup

Selecting the RESP label on the screen opens the following menu.

The screenshot shows a menu titled "RESP SETUP" with a teal header. The menu items are arranged in two columns. The first column contains: ALM (set to ON), ALM LEV (set to MED), ALM REC (set to OFF), ALM HI (set to 30), ALM LO (set to 8), and APNEA ALM (set to 20S). The second column contains: SWEEP (set to 6.25), HOLD TYPE (set to AUTO), HOLD HI, HOLD LO, and CONFIG >>. At the bottom, there is a grey bar with the text "Open or close the RESP alarm." and an "EXIT" button.

Figure 10-25 RESP Setup Menu

In this menu, you can perform the following settings.

- ALM Alarm on/off
ON: When a respiration rate alarm occurs, the monitor gives alarm indications and stores the alarm;
OFF: When a respiration rate alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
When OFF is selected, the  icon is displayed on the right of the RESP label.
- ALM LEV Alarm level
Options: HIGH, MED and LOW.
- ALM REC Alarm recording
ON: When a respiration rate alarm occurs, the monitor enables the recording;
OFF: When a respiration rate alarm occurs, the monitor does not enable the recording
- ALM HI Upper alarm limit
Determines the upper limit of respiration rate alarm.
- ALM LO Lower alarm limit
Determines the lower limit of respiration rate alarm.

For different patient types, the upper/lower limits of the respiration rate alarm may vary in the following range.

Patient type	Upper Limit	Lower Limit	Increment (breath/min)
Adult	(lower limit+2) ~120	0~(upper limit-2)	1
Neonate/pediatric	(lower limit+2) ~150	0~(upper limit-2)	1

- APNEA ALM Apnea alarm

Determines whether the patient's cessation of breath is an apnea event. Range: 10 - 40 seconds.
- SWEEP Waveform speed

Options: 6.25, 12.5 and 25.0 mm/s.
- HOLD TYPE Calculation type

Options: AUTO and MANUAL

 1. AUTO: When AUTO is selected, the monitor automatically determines the detection threshold for respiration and calculates the respiration rate. The HOLD HI and HOLD LO options are inactive.
 2. MANUAL: When MANUAL is selected, the user determines the detection threshold for respiration and the monitor calculates the respiration rate depending on the user-selected criteria.
- CONFIG >> Select CONFIG >> to access the RESP CONFIG menu. You can select either FACTORY CONF or USER CONF. After finishing the selection and exiting the menu, a dialog box pops up asking for confirmation of your selection.

10.9 Maintenance and Cleaning

WARNING

- **Before cleaning the ECG cable, be sure to disconnect the monitor from the ECG cable, or shut down the system and disconnect all power cords from the outlet.**
 - **If the ECG cable is damaged or aged, replace with a new one.**
-

■ Cleaning

The exterior surfaces of the ECG cable may be cleaned with a soft cloth, dampened with the alcohol, and then be air-dried or dried with a clean dry cloth.

■ Disinfection

Disinfection may cause damage to the equipment. We recommend the disinfection be contained in the hospital's servicing schedule only when necessary. The equipment should be cleaned prior to disinfection.

■ Sterilization

Sterilization may cause damage to the equipment. We recommend the sterilization be contained in the hospital's servicing schedule only when necessary. The equipment should be cleaned prior to sterilization.

FOR YOUR NOTES

11 SpO₂ Monitoring

11.1 Overview

The monitor measures the patients' SpO₂ (oxygen saturation) and displays:

1. Pulse rate (PR) value in the ECG or SpO₂ parameter window.
2. PLETH waveform in the waveforms area.
3. Oxygen saturation (SpO₂%) value in the SpO₂ parameter window.

The PR value is displayed in the ECG parameter window only if:

1. SpO₂ is selected from the HR FROM options in the ECG SETUP menu; or
2. AUTO is selected from the HR FROM options in the ECG SETUP menu and no ECG signal is received.

As the following figure shows, the PLETH waveform is located on the left while the SpO₂ parameter window on the right. The SpO₂ value is displayed by percentage and is followed by a perfusion indicator (pro rata with the pulse intensity). Besides, the SpO₂ label at the upper left corner of the parameter window allows you to access the SpO₂ SETUP menu.

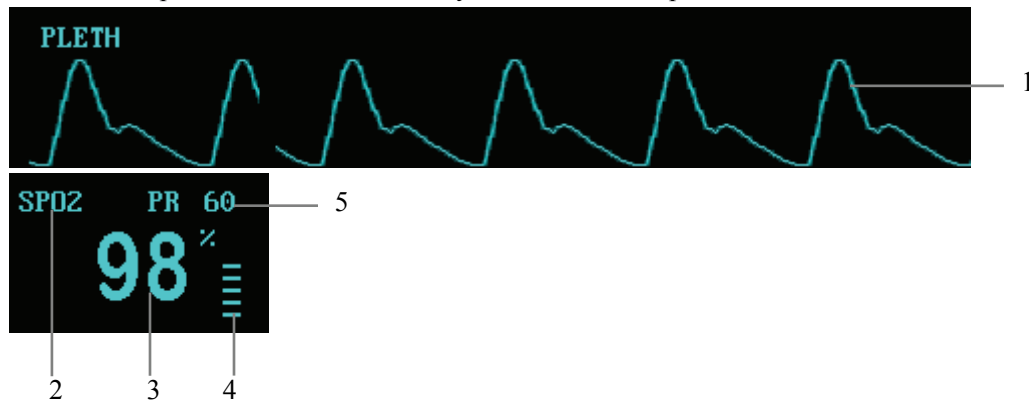


Figure 11-1 SpO₂ Waveform and Parameter

1. PLETH waveform
2. SPO2 label
3. SpO₂ value
4. Perfusion indicator
5. Pulse rate

PITCH TONE

The PITCH TONE function refers to the monitor's capability to vary the pitch of the heart rate tone or pulse rate tone with the change of the SpO₂ reading. This monitor provides 22 pitch levels. The pitch rises as the SpO₂ reading increases toward 100% and falls as it decreases. Although the tone pitch cannot be adjusted manually, the tone volume can be adjusted by one of the following two ways, depending on the setting of the HR FROM item in the ECG SETUP menu:

- If the HR FROM is set to SPO2 or IBP, you can adjust the PITCH TONE volume by changing the setting of the PR SOUND item in the SPO2 SETUP or IBP (1,2) SETUP menu;
- In case of other settings, you can adjust the PITCH TONE volume by changing the setting of the BEAT VOL item in the ECG SETUP menu.

If the PR SOUND or BEAT VOL is set to 0, the PITCH TONE function will be muted; if the SpO₂ module is disabled, the PITCH TONE function will be disabled as well.

NOTE

-
- SpO₂ and SPO2 are used interchangeably in this chapter.
-

11.2 Mindray DS SpO₂ Module

NOTE

-
- This section is only applicable to the monitor equipped with a Mindray DS SpO₂ module.
-

11.2.1 Principles of Operation

SpO₂ monitoring is a non-invasive technique used to measure the amount of oxygenated hemoglobin and pulse rate by measuring the absorption of selected wavelengths of light. The light generated in the probe passes through the tissue and is converted into electrical signals by the photodetector in the probe. The SpO₂ module processes the electrical signal and displays on the screen a waveform and digital values for SpO₂ and pulse rate.

The sensor measurement wavelengths are nominally 660nm for the red LED and 940nm for infrared LED. The maximum optical power output for LED is 4mW.

11.2.2 Precautions

WARNING

- The SpO₂ value might be overestimated in the presence of Hb-CO, Met-Hb or dye dilution chemicals.
 - Check if the sensor cable is in normal condition before monitoring. Do not use the SpO₂ sensor once the package or the sensor is found damaged.
 - Verify sensor cable fault detection before beginning monitoring. Unplug the SpO₂ sensor cable from the connector. The screen will display the prompt information “SPO2 SENSOR OFF” and the audible alarm is activated.
 - ES (Electrosurgery) equipment wire and SpO₂ cable must not be tangled up.
 - Do not put the SpO₂ sensor on the limb with arterial catheter or venous syringe.
 - Do not perform SpO₂ and NIBP measurements on the same limb simultaneously. Obstruction of blood flow during NIBP measurements may adversely affect the reading of the SpO₂ value.
 - Prolonged continuous monitoring may increase the risk of undesirable changes in skin characteristics, such as irritation, reddening, blistering or burns. Inspect the sensor site every two hours and move the sensor if the skin quality changes. Change the application site every four hours. For neonates or patients with poor peripheral blood circulation or sensitive skin, inspect the sensor site more frequently.
-

11.2.3 Monitoring Procedure

Sensor selection for SpO₂ measurement depends on the patient type. For an adult patient, you can choose a finger SpO₂ sensor; for an infant patient, you can choose a hand or toe sensor. Refer to the following procedure.

1. Power on the monitor.
2. Attach the sensor to the proper site on the patient.
3. Plug the connector of the sensor extension cable into the SpO₂ connector on monitor.

Finger Sensor Placement

You can easily place the finger sensor as shown below.

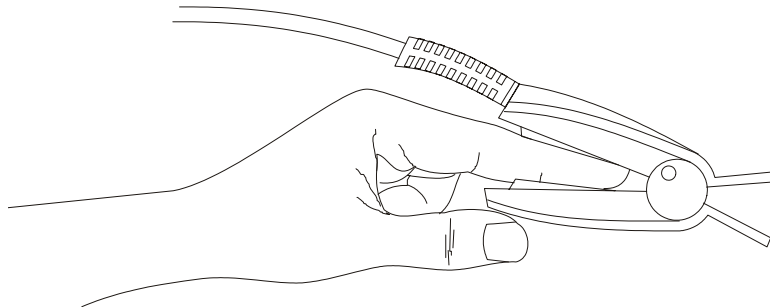


Figure 11-2 Finger Sensor Placement

NOTE

- Place the SpO₂ sensor cable at the backside of the patient hand. Make sure the fingernail is just opposite to the light emitted from the sensor.
-

Neonate Sensor Placement

Neonate SpO₂ sensor consists of a Y-shape SpO₂ sensor and its sheath. Insert the LED and PD ends of the Y-shape SpO₂ sensor respectively into the upper and lower grooves on the sheath (*Figure 11-3*). The *Figure 11-4* shows us the neonate SpO₂ sensor after insertion.

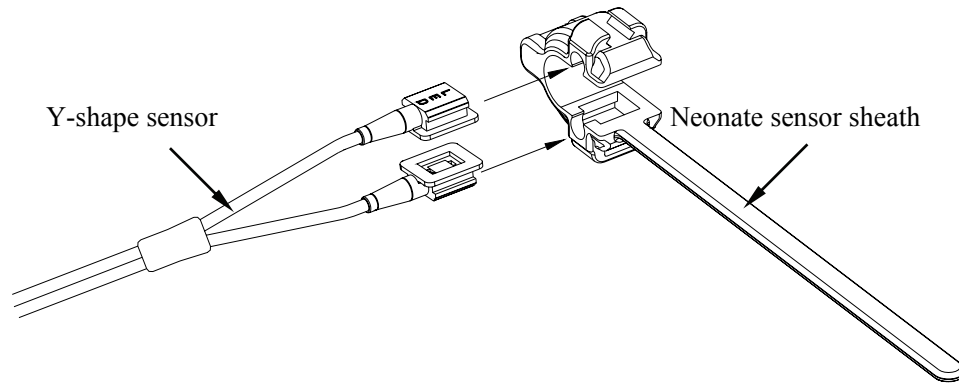


Figure 11-3 Neonate Sensor Placement (1)

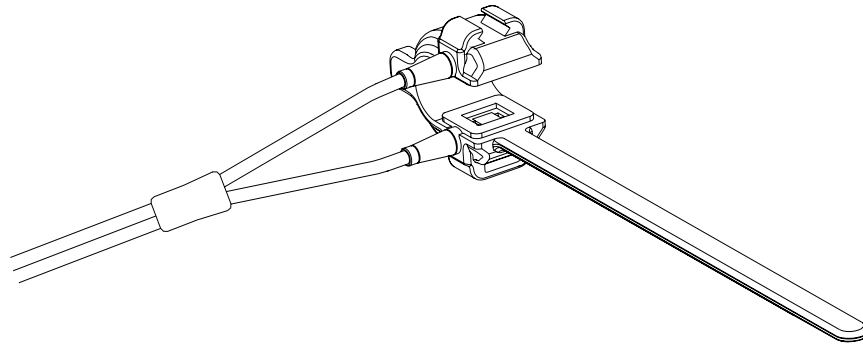


Figure 11-4 Neonate Sensor Placement (2)

Wind the SpO₂ sensor around a hand or foot of a neonate patient. Hold the sensor, pull the belt and fit one of its sides with “V” edge into the “V” groove on the corresponding side of the sheath. Appropriately elongate the belt to about 20mm, and fit the “V” edge of the other side of the belt into the “V” groove of the other side of the sheath. Then, loosen the belt. After the “V” edges of the two sides of the belt fit well into the “V” grooves on the two sides of the sheath, put the belt into the first lock bar to fasten the belt. See *Figure 11-5*. If the belt is too long, you may put it into the second lock bar. You must position the SpO₂ sensor in this way so as to make the photoelectric component face the correct position. Besides, note not to elongate the belt too much, which may lead to inaccurate measurement and block the blood circulation severely.



Figure 11-5 Neonate Sensor Placement (3)

NOTE

- If the sensor cannot be positioned accurately to the part to be measured, it may result in inaccurate SpO₂ reading, or the SpO₂ even cannot be measured because no pulse is detected. In this case, you must position the sensor again.
- The excessive patient movement may result in inaccurate reading. In this situation, you must keep the patient quiet or change the measured position to reduce the adverse influence of excessive movement.

WARNING

- In the process of extended and continuous monitoring, you should check the peripheral circulation and the skin every 2 hours. If any unfavorable change takes place, you should change the measured position in time.
 - In the process of extended and continuous monitoring, you should periodically check the position of the sensor. In case that the position of the sensor moves during monitoring, the measurement accuracy may be affected.
-

11.2.4 Measurement Limitations

If the accuracy of any measurement does not seem reasonable, first check the patient's vital signs by an alternate method. Then check the instrument for proper function. Inaccurate measurements may be caused by:

- Improper SpO₂ sensor;
- High-frequency electrical noise, including noise created by the host system, or noise from external sources, such as electrosurgical apparatus connected to the system;
- Oximeters and oximetry sensors used during magnetic resonance imaging (MRI) scanning. Induced current could potentially cause burns;
- Intravascular dye injections;
- Excessive patient motion;
- Excessive ambient light;
- Improper sensor installation or incorrect sensor placement on the patient
- Sensor temperature (optimal temperature is between 28°C and 40°C);
- The sensor is placed on a limb that is attached to a blood pressure cuff, arterial catheter, or intravascular line;
- Concentration of dysfunctional hemoglobin, such as carboxyhemoglobin and methemoglobin;
- SpO₂ too low;
- Low circular perfusion of the applied part;
- Shock, anemia, low temperature and application of vasomotor all reduce the arterial blood flow and may affect the pulse oximetry measurement.

The absorption of oxyhemoglobin (HbO₂) and deoxyhemoglobin to the light of special wavelength may also affect SpO₂ measurement. If there exist other substances (like carbon hemoglobin, methemoglobin, methylene blue and indigo carmine) absorbing the light of the same wavelength, they may result in false or low SpO₂ reading.


11.2.5 SpO₂ Setup Menu

Selecting the SPO₂ label in the parameter window opens the following menu.

SPO2 SETUP			
ALM	ON	PR ALM LO	50
ALM LEV	MED	SWEEP	25.0
ALM REC	OFF	PR SOUND	2
SPO2 ALM HI	100	SENSITIVE	MED
SPO2 ALM LO	90	NIBP SIMUL	OFF
PR ALM HI	120	CONFIG >>	
Back to the upper menu.			
EXIT			

Figure 11-6 SpO₂ Setup Menu

You can perform the following settings in this menu.

- **ALM** SpO₂ alarm on/off status
ON: When a SpO₂ alarm occurs, the monitor gives alarm indications and stores the alarm;
OFF: When a SpO₂ alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
When OFF is selected, the  icon is displayed on the right of the SPO₂ label.
- **ALM LEV** Alarm level
Options: HIGH and MED.
- **ALM REC** Alarm recording
ON: When a SpO₂ alarm occurs, the monitor enables the recording;
OFF: When a SpO₂ alarm occurs, the monitor does not enable the recording.
- **SPO₂ ALM HI** SpO₂ upper alarm limit
- **SPO₂ ALM LO** SpO₂ lower alarm limit
- **PR ALM HI** PR upper alarm limit
- **PR ALM LO** PR lower alarm limit

SpO₂ and PR alarm limits:

Parameter	Upper Limit	Lower Limit	Step
SpO ₂	(lower limit+1) ~100	0~(upper limit-1)	1
PR	(lower limit+2) ~254	0~(upper limit-2)	1

The SpO₂ and PR alarm limits in factory configuration:

Parameter	Patient type	Upper limit	Lower limit
SpO ₂	Adult	100	90
	Pediatric	100	90
	Neonate	95	90
PR	Adult	120	50
	Pediatric	160	75
	Neonate	200	100

 **WARNING**

- **Setting the SpO₂ upper alarm limit to 100% will disable the upper alarm limit. High oxygen levels may predispose a premature infant to retrolental fibroplasia. Therefore, the upper alarm limit for oxygen saturation must be carefully selected in accordance with the commonly accepted clinical practices.**
-

- **SWEEP** Waveform speed
Options: 12.5 and 25.0 mm/s.
- **PR SOUND** Pulse volume
Range: 0 - 10. 0 indicates the volume is closed and 10 indicates the maximum volume.
- **SENSITIVE** Sensitivity of SpO₂ calculation
Options: HIGH, MED and LOW.
When HIGH is selected, the monitor gives quick response to the change of the oxygen saturation but the measurement accuracy might be compromised.
When LOW is selected, the monitor gives slow response to the change of the oxygen saturation but the accuracy is relatively high.
- **NIBP SIMUL** ON: When measuring NIBP and SpO₂ at the same side, the SpO₂ alarm status remains unchanged until the NIBP measurement is finished;
OFF: The function of NIBP SIMUL is disabled.

■ CONFIG >>

You can select this option to access the SPO2 CONFIG menu, in which you may select FACTORY CONFIG or USER CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

11.3 Nellcor SpO₂ Module

NOTE

-
- **This section is only applicable to the monitor equipped with a Nellcor SpO₂ module.**
-

11.3.1 Principles of Operation

Bone, tissue, pigmentation, and venous vessels normally absorb a constant amount of light over time. The arteriolar bed normally pulsates and absorbs variable amounts of light during the pulsations. The Nellcor SpO₂ module uses pulse oximetry to measure functional oxygen saturation in the blood. Pulse oximetry works by applying a sensor to a pulsating arteriolar vascular bed, such as a finger or toe. The sensor contains a dual light source and a photodetector. The ratio of light absorbed is translated into a measurement of functional oxygen saturation (SpO₂).

■ Oximetry Overview

Pulse oximetry is based on two principles:

1. Oxyhemoglobin and deoxyhemoglobin differ in their absorption of red and infrared light (i.e., spectrophotometry).
2. The volume of arterial blood in tissue (and hence, light absorption by that blood) changes during the pulse (i.e., plethysmography).

A monitor determines SpO₂ by passing red and infrared light into an arteriolar bed and measuring changes in light absorption during the pulsatile cycle. Red and infrared low-voltage light-emitting diodes (LEDs) in the oximetry sensor serve as light sources; a photodiode serves as the photo detector.

Because oxyhemoglobin and deoxyhemoglobin differ in light absorption, the amount of red and infrared light absorbed by blood is related to hemoglobin oxygen saturation. To identify the oxygen saturation of arterial hemoglobin, the monitor uses the pulsatile nature of arterial flow. During systole, a new pulse of arterial blood enters the vascular bed, and blood volume and light absorption increase. During diastole, blood volume and light absorption reach their lowest point. The monitor bases its SpO₂ measurements on the difference between maximum and minimum absorption (i.e., measurements at systole and diastole). By doing so, it focuses on light absorption by pulsatile arterial blood, eliminating the effects of nonpulsatile absorbers such as tissue, bone, and venous blood.

■ Automatic Calibration

Because light absorption by hemoglobin is wavelength dependent and because the mean wavelength of LEDs varies, a monitor must know the mean wavelength of the sensor's red LED to accurately measure SpO₂. During manufacturing, the mean wavelength of the red LED is encoded in a resistor in the sensor. During monitoring, the monitor reads this resistor and selects coefficients that are appropriate for the wavelength of that sensor's red LED; these coefficients are then used to determine SpO₂.

This resistor is read when the monitor is turned on, periodically thereafter, and each time a new sensor is connected. Additionally, to compensate for differences in tissue thickness, the intensity of the sensor's LEDs is adjusted automatically.

■ Functional versus Fractional Saturation

This monitor measures functional saturation — oxygenated hemoglobin expressed as a percentage of the hemoglobin that can transport oxygen. It does not detect significant amounts of dysfunctional hemoglobin, such as carboxyhemoglobin or methemoglobin. In contrast, some instruments report fractional saturation — oxygenated hemoglobin expressed as a percentage of all measured hemoglobin, including measured dysfunctional hemoglobins. To compare functional saturation measurements to those from an instrument that measures fractional saturation, fractional measurements must be converted as follows:

$$\text{Functional saturation} = \frac{\text{Fractional saturation}}{100 - (\% \text{carboxyhemoglobin} + \% \text{methemoglobin})} \times 100$$

■ Measured versus Calculated Saturation

When saturation is calculated from a blood gas partial pressure of oxygen (PO₂), the calculated value may differ from the SpO₂ measurement of a monitor. This usually occurs because the calculated saturation was not appropriately corrected for the effects of variables that shift the relationship between PO₂ and saturation (**Figure 11-7**): pH, temperature, the partial pressure of carbon dioxide (PCO₂), 2,3-DPG, and fetal hemoglobin.

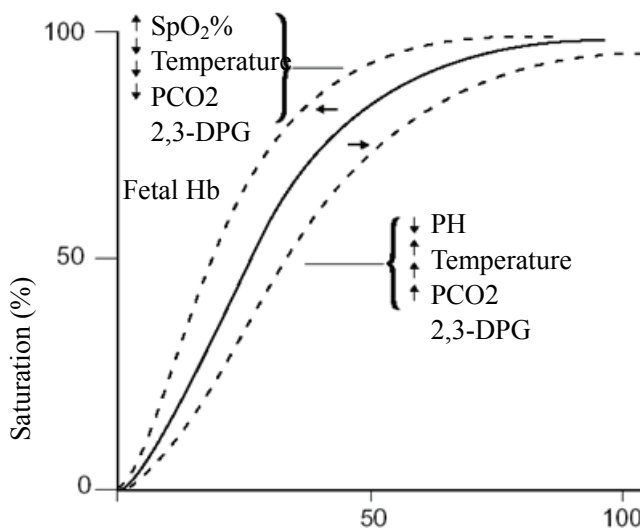


Figure 11-7 Oxyhemoglobin Dissociation Curve

11.3.2 Precautions

WARNING

- Pulse oximeter can overestimate the SpO₂ value in the presence of Hb-CO, Met-Hb or dye dilution chemicals.
 - ES (Electrosurgery) equipment wire and SpO₂ cable must not be tangled up. Carefully route patient cabling to reduce the possibility of patient entanglement or strangulation.
 - Do not use this instrument and the sensors during magnetic resonance imaging (MRI). Induced current could potentially cause burns. The monitor may affect the MRI image, and the MRI unit may affect the accuracy of the oximetry measurements.
 - Do not put the SpO₂ sensor on the limb with arterial catheter or venous syringe.
 - Do not use the supplied sterile SpO₂ sensors if the packaging or the sensor is damaged. Return them to the distributor or manufacturer.
 - Do not perform SpO₂ monitoring and NIBP measurements on the same arm simultaneously. Obstruction of blood flow during NIBP measurements may adversely affect the reading of the SpO₂ value.
 - Before performing the testing, check the sensor cable. After unplugging the SpO₂ sensor cable from the socket, the system shall display the prompt information "SPO2 SENSOR OFF" and give the audible alarm.
 - Prolonged continuous monitoring may increase the risk of undesirable changes in skin characteristics, such as irritation, reddening, blistering or burns. Inspect the sensor site every two hours and move the sensor if the skin quality changes. Change the application site every four hours. For neonates or patients with poor peripheral blood circulation or sensitive skin, inspect the sensor site more frequently.
-

NOTE

- Place the SpO₂ sensor cable at the backside of the patient hand. Make sure the fingernail is just opposite to the light emitted from the sensor.
 - SpO₂ waveform is not proportional to the pulse volume.
-

11.3.3 Monitoring Procedure

Follow the procedure as below:

1. Power on the monitor.
2. Attach the sensor to the proper site on the patient.
3. Plug the connector of the sensor extension cable into the SpO₂ connector on monitor.

The process of SpO₂ plethysmogram measurement is generally the same. But the SpO₂ sensor selection and placement depend on the patient type. When choosing a site for a sensor, refer to the directions for that sensor.

11.3.4 Measurement Limitations

If the accuracy of any measurement does not seem reasonable, first check the patient's vital signs by an alternate method. Then check the instrument for proper function.

Inaccurate measurements may be caused by:

- Incorrect sensor application or use;
- Placement of a sensor on the same extremity with a blood pressure cuff, arterial catheter, or intravascular line;
- Exposure to excessive illumination, such as surgical lamps (especially ones with a xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps, or direct sunlight (exposure to excessive illumination can be corrected by covering the sensor with a dark material);
- Excessive patient motion;
- Venous pulsations;
- Intravascular dyes such as indocyanine green or methylene blue;
- Defibrillation;

Other physiological conditions or medical procedures that may interfere with the monitor's measurements include significant levels of dysfunctional hemoglobin, low perfusion, and dark pigment.

Loss of pulse signal can occur in the following situations:

- The sensor is too tight;
- A blood pressure cuff is inflated on the same extremity as the one with a SpO₂ sensor attached;
- There is arterial occlusion proximal to the sensor.

Select an appropriate sensor, apply it as directed, and observe all warnings and cautions presented in the directions for use accompanying the sensor. Clean and remove any substances such as nail polish from the application site. Periodically check to ensure that the sensor remains properly positioned on the patient.

If patient movement presents a problem, try one or more of the following remedies to correct the problem.

- Verify that the sensor is properly and securely applied.
- Move the sensor to a less active site.
- Use an adhesive sensor that tolerates some patient motion.
- Use a new sensor with fresh adhesive backing.

If poor perfusion affects performance, consider using the Oxisensor R-15 sensor; it obtains measurements from the nasal septal anterior ethmoid artery, an artery supplied by the internal carotid. This sensor may obtain measurements when peripheral perfusion is relatively poor. For low peripheral perfusion, consider using the Nellcor RS-10 sensor, which is applied to the forehead or temple. These are sites that may be spared during peripheral vasoconstriction.


11.3.5 SpO₂ Setup Menu

Selecting the SPO₂ label in the parameter window opens the following menu.

SPO2 SETUP			
ALM	ON	PR ALM LO	58
ALM LEV	MED	SWEEP	25.0
ALM REC	OFF	PR SOUND	2
SPO2 ALM HI	97	AVG TIME	4S
SPO2 ALM LO	90	NIBP SIMUL	OFF
PR ALM HI	120	CONFIG >>	
Open or close the SpO2 alarm.			
EXIT			

Figure 11-8 SpO₂ Setup Menu

You can perform the following settings in this menu.

- ALM SpO₂ alarm on/off status
ON: When a SpO₂ alarm occurs, the monitor gives alarm indications and stores the alarm;
OFF: When a SpO₂ alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
When OFF is selected, the  icon is displayed on the right of the SPO₂ label.
- ALM LEV Alarm level
Options: HIGH and MED.
- ALM REC ◆ Alarm recording
◆ ON: When a SpO₂ alarm occurs, the monitor enables the recording;
◆ OFF: When a SpO₂ alarm occurs, the monitor does not enable the recording.
- SPO₂ ALM HI SpO₂ upper alarm limit
- SPO₂ ALM LOW SpO₂ lower alarm limit
- PR ALM HI PR upper alarm limit
- PR ALM LO PR lower alarm limit

SpO₂ and PR alarm limits:

Parameter	Upper Limit	Lower Limit	Step
SpO ₂	(lower limit+1) ~100	0~(upper limit-1)	1
PR	(lower limit+2) ~254	0~(upper limit-2)	1

The SpO₂ and PR alarm limits in factory configuration:

Parameter	Patient type	Upper limit	Lower limit
SpO ₂	Adult	100	90
	Pediatric	100	90
	Neonate	95	80
PR	Adult	120	50
	Pediatric	160	75
	Neonate	200	100

 **WARNING**

- **Setting the SpO₂ upper alarm limit to 100% will disable the upper alarm limit. High oxygen levels may predispose a premature infant to retrolental fibroplasia. Therefore, the upper alarm limit for oxygen saturation must be carefully selected in accordance with the commonly accepted clinical practices.**
-

- SWEEP Waveform speed
Options: 12.5 and 25.0 mm/s.
- PR SOUND Pulse volume
Range: 0 - 10. 0 indicates the volume is closed and 10 indicates the maximum volume.
- AVG TIME Average time
Determines the average SpO₂ calculation time.
Options: 4S, 8S and 16S.
- NIBP SIMUL ON: When measuring NIBP and SpO₂ at the same side, the SpO₂ alarm status remains unchanged until the NIBP measurement is finished;
OFF: The function of NIBP SIMUL is disabled.
- CONFIG >> You can select this option to access the SPO2 CONFIG menu, in which you may select FACTORY CONFIG or USER CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

11.3.6 Accessories

If your monitor is equipped with a Nellcor SpO₂ module, use only Nellcor oximetry sensors for SpO₂ measurements. Other sensors may cause improper pulse oximeter performance. Before use, carefully read the directions for the sensor. When selecting a sensor, consider, the patient's weight and motion, the adequacy of perfusion, the available sensor sites, and the required disinfection.

Biocompatibility testing has been conducted on Nellcor sensors in compliance with ISO 10993-1, Biological Evaluation of Medical Devices, Part 1: Evaluation and Testing. The sensors have passed the recommended biocompatibility testing and are therefore in compliance with ISO 10993-1.

Before attempting to clean a SpO₂ sensor, read the directions for use enclosed with the sensor. Each sensor model has cleaning instructions specific to that sensor.

WARNING

- **Incorrect use of an oximetry sensor may cause damage to the patient's muscle. Verify the sensor site carefully according to the directions for use.**
-

11.3.7 Nellcor Information



Nellcor Patents

This device is covered under one or more the following U.S. Patents: 4,802,486; 4,869,254; 4,928,692; 4,934,372; 5,078,136; 5,351,685; 5,485,847; 5,533,507; 5,577,500; 5,803,910; 5,853,364; 5,865,736; 6,083,172; 6,463,310; 6,591,123; 6,708,049; Re.35,122 and international equivalents. U.S.A and international patents pending.

No Implied License

Possession or purchase of this device does not convey any express or implied license to use the device with replacement parts which would, alone, or in combination with this device, fall within the scope of one or more of the patents relating to this device.

FOR YOUR NOTES

12 NIBP Monitoring

12.1 Overview

The Non-invasive Blood Pressure (NIBP) module measures blood pressure using the oscillometric method. This monitor can be applied to adult, pediatric, and neonatal patients. Three modes of measurement are available: manual, automatic and continuous.

- Manual: Pressing the NIBP key on the control panel starts a NIBP measurement.
- Auto: The NIBP measurement is conducted automatically at a preset interval.
- Continuous: The NIBP measurement is performed as many times as possible in five minutes.

NOTE

- **Blood pressure measurements determined with this device are equivalent to those obtained by a trained observer using the cuff/stethoscope auscultatory method, within the limits prescribed by the American National Standard, Manual, electronic, or automated sphygmomanometers.**
-

The NIBP measurement does not produce any waveform. Instead, it displays the measurement result in the NIBP parameter window as shown below.

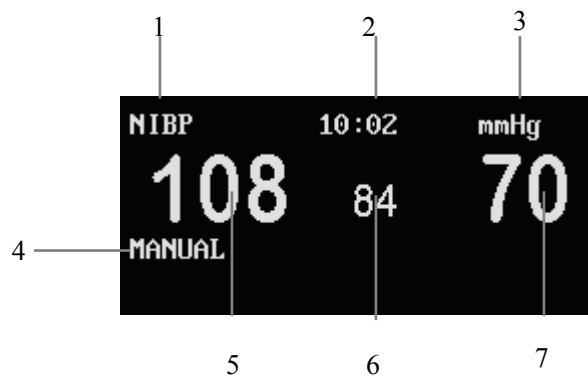


Figure 12-1 NIBP Parameter Window

1. NIBP label: Selecting this label to access the NIBP SETUP menu.
2. Time of last measurement.
3. NIBP unit: mmHg or kPa.
4. Prompt information area: Shows the NIBP measurement mode and other information.
5. Systolic pressure value (NS)
6. Mean pressure value (NM)
7. Diastolic pressure value (ND)

If a set of measured results appears in grey, it indicates this measurement is performed at least 1 hour ago.

12.2 Monitoring Procedure

WARNING

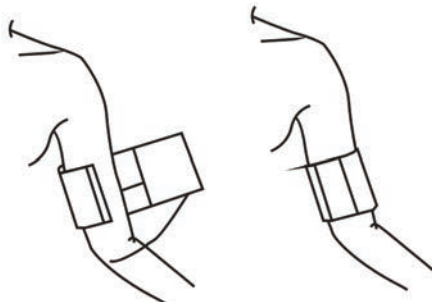
- **You must not perform NIBP measurements on patients with sickle-cell disease or under any condition in which the skin is damaged or expected to be damaged.**
 - **For a thrombocytopenia patient, it is important to determine whether measurement of the blood pressure shall be done automatically.**
 - **This monitor is suitable for use in the presence of electrosurgery.**
 - **Ensure that the setting is correctly made when performing measurements on children. Incorrect patient type setting may cause a danger to the patient because adult blood pressure level is higher than children.**
-

To perform NIBP measurement on a patient, follow the procedure as below

1. Power on the monitor.
2. Check the patient information area on the screen. If the patient type is incorrect, select a correct patient type in PATIENT SETUP menu.
3. Plug the air hose in the NIBP cuff connector of the monitor.
4. Apply a cuff of proper size to the upper arm or the leg of the patient.
5. Connect the cuff with the air hose.
6. Press the NIBP key on the control panel to start the NIBP measurement.

12.2.1 Cuff Selection and Placement

1. Identify the patient limb circumference.
2. Select appropriate cuff; limb circumference is identified on each cuff.
3. Verify the cuff is completely deflated; place cuff around extremity being used and make sure the marking Φ matches artery location.
4. Verify the cuff is not wrapped too tightly around the limb. Excessive tightness may cause discoloration or ischemia of the extremities.



-
5. Make sure that the cuff edge falls within the range of the <-> mark. If it does not, use a larger or smaller cuff that will fit better.
 6. The limb chosen for taking the measurement should be placed at the same level as the patient's heart. If this is not possible, use the following method to correct the measurement result:
 - If the cuff is placed higher than the heart level, add 0.75 mmHg (0.10 kPa) for each centimeter of difference.
 - If it is placed lower than the heart level, deduct 0.75 mmHg (0.10 kPa) for each centimeter of difference.

 **WARNING**

- **The width of the cuff should be either 40% of the limb circumference (50% for neonates) or 2/3 of the upper arm length. The inflatable part of the cuff should be long enough to circle 50-80% of the limb. The wrong size cuff can cause erroneous readings. If the cuff size is in question, use a larger cuff.**
 - **Do not apply the cuff to a limb that has an intravenous infusion or catheter in place. This could cause tissue damage around the catheter when infusion is slowed or blocked during cuff inflation.**
 - **Make sure the air tubing connecting the blood pressure monitor is not blocked, twisted, or tangled.**
-

12.2.2 Operation Guides

1. To start a manual NIBP measurement
 - Access the NIBP SETUP menu and select MANUAL from the INTERVAL option; then, press the NIBP key on the control panel to start a manual NIBP measurement; or
 - During the interval between two auto NIBP measurements, press the NIBP key on the control panel to start a manual NIBP measurement.

2. To start auto NIBP measurement

Access the NIBP SETUP menu and select a time (e.g. 5MIN) from the INTERVAL options; press the NIBP key on the control panel to start the auto NIBP measurement. When this measurement finishes, the system will perform the NIBP measurement automatically as per the preset interval.

 **WARNING**

- **Auto non-invasive blood pressure measurements performed in long intervals may incur ischemia and neuropathy in the limb wearing the cuff. When monitoring a patient, examine the extremities of the limb frequently for normal color, warmth and sensitivity. If any abnormality is observed, change the position of the cuff on the patient or stop the blood pressure measurements immediately.**
-

3. To start a continuous NIBP measurement

Selecting CONTINUAL in NIBP SETUP menu starts a continuous NIBP measurement. The monitor continues measuring NIBP for five minutes.

4. To stop a NIBP measurement

During an auto, manual or continuous measurement, pressing the NIBP key on the control panel stops the ongoing measurement.

NOTE

-
- **If you are in doubt about the accuracy of any reading(s), check the patient's vital signs by an alternative method before checking the function of the monitor.**
-

12.3 Measurement Limitations

Non-invasive blood pressure measurement uses the oscillometric method of measurement. The monitor detects the regular arterial pressure pulse. In some circumstances when the patient's condition makes it difficult to detect this pulse, the measurement becomes unreliable and the measurement time increases. You should be aware that the following conditions could interfere with the measurement, make the measurement unreliable, prolong the measurement, or even make a measurement impossible.

- Patient Movement

E.g. The patient is moving, shivering, or having convulsions.

- Cardiac Arrhythmia's

E.g. The patient's cardiac arrhythmia has caused an irregular heartbeat.

- Heart-lung Machine

E.g. Measurements will be impossible if the patient is connected to a heart-lung machine.

- Pressure Changes

E.g. The patient's blood pressure is changing rapidly over the period of time during which the arterial pressure pulses are being analyzed to obtain the measurement.

- Severe Shock

E.g. If the patient is in severe shock or hypothermia, reduced blood flow to the peripheries will cause reduced pulsation of the arteries.

- Heart Rate Extremes

The monitor is unable to perform pressure measurements at a heart rate of less than 40 bpm and greater than 240 bpm.


12.4 NIBP Setup Menu

Selecting the NIBP label in the parameter area opens the following menu.

NIBP SETUP			
ALM	ON	DISPLAY WAY	1 GROUP
ALM LEV	MED	UNIT	mmHg
ALM REC	OFF	INTERVAL	MANUAL
SYS ALM HI	160	RESET	
SYS ALM LO	90	CONTINUAL	
MEAN ALM HI	110	CALIBRATE	
MEAN ALM LO	60	PNEUMATIC	
DIA ALM HI	90	CONFIG >>	
DIA ALM LO	50		
Open or close the NIBP alarm.			
EXIT			

Figure 12-2 NIBP Setup Menu

You can perform the following settings in this menu.

- ALM NIBP alarm on/off status
ON: When a NIBP alarm occurs, the monitor gives alarm indications and stores the alarm;
OFF: When a NIBP alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
When OFF is selected, the  icon is displayed on the right of the NIBP label.
- ALM LEV Alarm level
Options: HIGH and MED.
- ALM REC Alarm recording
ON: When an NIBP alarm occurs, the monitor enables the recording;
OFF: When a NIBP alarm occurs, the monitor does not enable the recording.

- **SYS ALM HI** Determines the upper limit of the systolic pressure.
- **SYS ALM LO** Determines the lower limit of the systolic pressure.
- **MEAN ALM HI** Determines the upper limit of the mean pressure.
- **MEAN ALM LO** Determines the lower limit of the mean pressure.
- **DIA ALM HI** Determines the upper limit of the diastolic pressure.
- **DIA ALM LO** Determines the lower limit of the diastolic pressure.

If a measured pressure crosses a preset upper or lower alarm limit, an alarm will be triggered.
The NIBP alarm limits are as follows:

Patient type	Adult		Pediatric		Neonate	
	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit
Systolic pressure (mmHg)	(lower limit+2) ~270	40~(upper limit-2)	(lower limit+2) ~200	40~(upper limit-2)	(lower limit+2) ~135	40~(upper limit-2)
Mean pressure (mmHg)	(lower limit+2) ~230	20~(upper limit-2)	(lower limit+2) ~165	20~(upper limit-2)	(lower limit+2) ~110	20~(upper limit-2)
Diastolic pressure (mmHg)	(lower limit+2) ~210	10~(upper limit-2)	(lower limit+2) ~150	10~(upper limit-2)	(lower limit+2) ~100	10~(upper limit-2)

The alarm limits in factory configuration (Unit: mmHg):

Patient type	Adult	Pediatric	Neonate
Sys alarm high	160	120	90
Sys alarm low	90	70	40
Mean alarm high	110	90	70
Mean alarm low	60	50	25
Dia alarm high	90	70	60
Dia alarm low	50	40	20

- **DISPLAY WAY**

1 GROUP: The NIBP parameter area only displays a group of NIBP values obtained in the latest measurement.

GROUPS: Multiple groups of measurement values are displayed at the lower left corner of the screen as shown below.

NS	NM	ND	PR	DATE	TIME
108	84	70	68	2006-6-12	16:06:00
108	80	70	67	2006-6-12	16:11:00
108	80	70	72	2006-6-12	16:16:00

- UNIT Options: mmHg, kPa;
- INTERVAL Select MANUAL to set the monitor to manual NIBP measurement mode, or select from the time options to determine the interval between automatic measurements.
Optional intervals: 1, 2, 3, 4, 5, 10, 15, 30, 60, 90, 120, 180, 240, and 480MIN.
- RESET Select this option to restore the initial settings of the pressure pump. If the monitor fails to give a visual indication when the pressure pump is working improperly, selecting this option activates a self-test procedure, and restores the monitor to normal performance.
- CONTINUAL Select this option to start a continuous measurement for five minutes.
- CONFIG >> You can select this option to access the NIBP CONFIG menu, in which you may select FACTORY CONFIG or USER CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

12.4.1 Calibration

If you select the CALIBRATE option, the monitor starts the NIBP calibration and the CALIBRATE option changes to STOP CAL. Selecting the option again stops the calibration.

Calibrate the cuff pressure reading with a calibrated reference manometer (or mercury manometer) with accuracy higher than 1mmHg. To perform the calibration, follow the procedure shown below:

1. Remove the blood pressure cuff from the monitor and replace it with a rigid metal container or vessel with a capacity of 500 ml \pm 5%.
2. Connect a calibrated reference manometer (with an error less than 1mmHg) and a ball pump using "T" connectors as shown below.
3. Select the CALIBRATE option.
4. Inflate the metal container using the ball pump until the reference manometer reads 0, then 50, and finally 200 mmHg.
5. The difference between the indicated pressure of the reference manometer and the indicated pressure of the monitor will not exceed 3 mmHg. Contact our Customer Service if these values are not met.

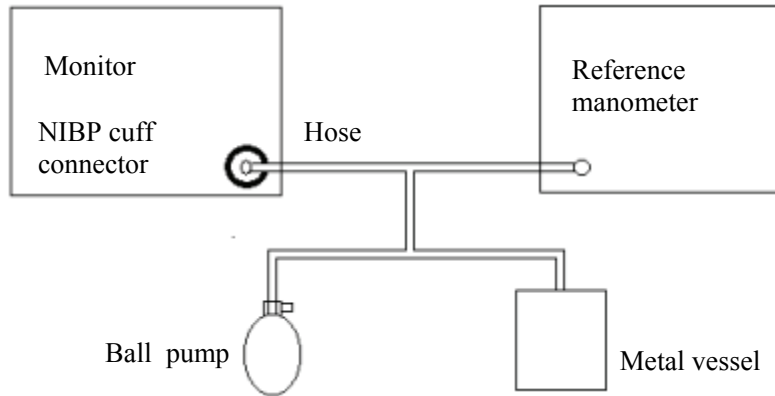


Figure 12-3 NIBP Calibration

NOTE

- **The calibration of the NIBP measurement should be performed every two years or performed according to the Hospital Procedure.**

12.4.2 Testing for Air Leakage

The PNEUMATIC option is used to test air leakage. When the NIBP cuff is connected, select this option to start the NIBP inflation and test whether the air leakage occurs in the airway. If the test is passed, no prompt information will be displayed; if the test is not passed, corresponding prompt information will be displayed in the NIBP parameter window.

To test air leakage, use the following procedure:

1. Set PAT TYPE to ADU.
2. Connect a rigid metal container or vessel with a capacity of 500 ml \pm 5% to the NIBP cuff connector of the monitor.

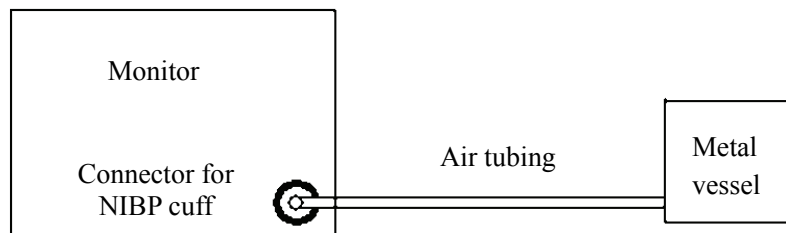


Figure 12-4 NIBP Leakage Test

3. Select the PNEUMATIC option, and the information “Pneum testing...” is displayed at the lower left corner of the NIBP parameter window.
4. After approximately 20 seconds, the monitor will automatically open the deflate valve, ending the test.

-
5. If no information appears on the bottom of the NIBP parameter area, it indicates the airway is in good condition and an air leak does not exist. However if the information “PNEUMATIC LEAK” appears, it indicates the airway may have an air leak. In this case, check for loose connections. After confirming all connections are secure, perform the test again.

If there is still a failure, contact our Customer Service.

NOTE

-
- Set PAT TYPE to ADU in the PATIENT SETUP menu before leakage test.
 - The pneumatic test, other than being specified in the EN 1060-1 standard, is to be used to simply determine whether there are air leaks in the NIBP airway.
-

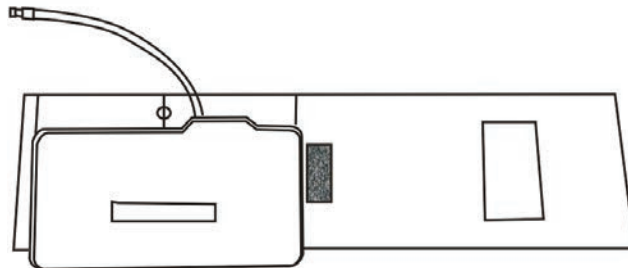
12.5 Maintenance and Cleaning

WARNING

- Do not press the rubber tube on the cuff with excessive strength.
 - When a reusable cuff is not connected to the monitor or is being cleaned, always cover the rubber tube with a lid. Avoid splashing liquid into the rubber tube or the monitor inadvertently.
-

Reusable Blood Pressure Cuffs

The cuff is not suitable for dry-cleaning. Instead, it should be machine or hand washed. Hand washing, may prolong the service life of the cuff. Before washing, remove the latex rubber bladder. Allow the cuff to dry thoroughly after washing, and then reinsert the rubber bladder. The cuff can be disinfected by means of conventional autoclaving, gas, or radiation disinfection in hot air ovens, or sterilized by immersion in decontamination solutions. Remember to remove the rubber bladder if you use this method



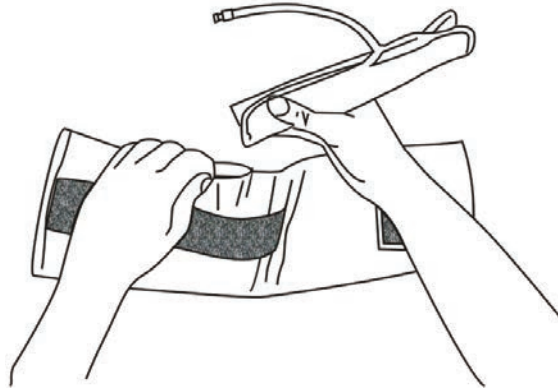


Figure 12-5 Replacing the Rubber Bladder

To replace the rubber bladder in the cuff:

1. Place the bladder on top of the cuff so the rubber tubes line up with the large opening on the long side of the cuff.
2. Roll the bladder lengthwise and insert it into the opening on the long side of the cuff.
3. Hold the tubes and the cuff and shake the complete cuff until the bladder is in position.
4. Thread the rubber tubes from inside the cuff, and out through the small hole under the internal flap.

⚠ CAUTION

- **Some disinfectants may cause skin irritation. Please rinse cuff thoroughly with water to remove any residual disinfectants. Using dark colored disinfectants may stain the cuffs. Test a single cuff to ensure that no damage will occur.**
-

Disposable Blood Pressure Cuffs

Disposable cuffs are intended for single patient use only. Do not sterilize or use autoclave sterilization for disposable cuffs.

NOTE

- **Disposable blood pressure cuffs must be recycled or disposed of properly.**
-

13 TEMP Monitoring

13.1 Overview

The monitor is able to use two temperature probes simultaneously, to obtain two temperature values and the difference between them. The measurement values are displayed in the TEMP parameter window as shown below.

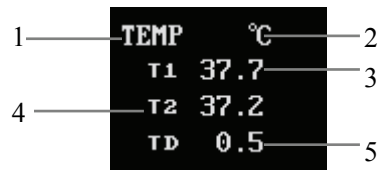


Figure 13-1 TEMP Parameter Window

1. TEMP label: Selecting this label opens the TEMP SETUP menu.
2. Temperature unit: °C or °F.
3. T1: Temperature channel 1. Displays the temperature measured at temperature channel 1.
4. T2: Temperature channel 2. Displays the temperature measured at temperature channel 2.
5. TD: Temperature difference, namely the difference between temperature 1 and temperature 2.

13.2 Measurement Procedure

To measure the temperature of a patient,

1. If a disposable temperature probe is used, plug the temperature probe cable in the temperature probe connector on the side panel of the monitor, and then connect the temperature probe with the cable; if a reusable temperature probe is used, connect the temperature probe with the temperature probe connector directly.
2. Attach the temperature probe to the patient properly.
3. Power on the monitor.

NOTE

-
- **Disposable temperature probes are for single patient use only.**
 - **The self-test of the temperature measurement is performed once per hour during monitoring. This self-test lasts about 2 seconds and does not affect the normal measurement of temperature.**
-



WARNING

-
- **Verify probe cable fault detection before beginning monitoring. Unplug the temperature probe cable of channel 1 or channel 2 from the connector on the monitor. The monitor will display the prompt information “T1 SENSOR OFF” or “T2 SENSOR OFF” and an audible alarm is activated. The other channel is the same.**
 - **Be careful to avoid damaging the temperature probe and cable. When the temperature probe and cable are not in use, shape them into a loose round. If the cable is tangled too tightly or over-bent, mechanical damage may occur.**
 - **The calibration of the temperature measurement function is required every two years (or as dictated by your Hospital Procedures Policy). If you need to calibrate the temperature measurement function, contact our Customer Service.**
-


13.3 TEMP Setup Menu

Selecting the TEMP label in the parameter window opens the following menu.

TEMP SETUP			
ALM	ON	T2 ALM HI	39.0
ALM LEV	MED	T2 ALM LO	36.0
ALM REC	OFF	TD ALM HI	2.0
T1 ALM HI	39.0	TEMP UNIT	°C
T1 ALM LO	36.0	CONFIG >>	
Open or close the TEMP alarm.			
EXIT			

Figure 13-2 TEMP Setup Menu

You can perform the following settings in this menu.

- ALM Temperature alarm on/off status
ON: When a temperature alarm occurs, the monitor gives alarm indications and stores the alarm;
OFF: When a temperature alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
When OFF is selected, the  icon is displayed on the right of the TEMP label.
- ALM LEV Alarm level
Options: HIGH, MED and LOW.
- ALM REC Alarm recording
ON: When a TEMP alarm occurs, the monitor enables the recording;
OFF: When a TEMP alarm occurs, the monitor does not enable the recording.

- T1 ALM HI Determines the upper alarm limit of temperature channel 1.
- T1 ALM LO Determines the lower alarm limit of temperature channel 1.
- T2 ALM HI Determines the upper alarm limit of temperature channel 2.
- T2 ALM LO Determines the lower alarm limit of temperature channel 2.
- TD ALM HI Determines the upper limit of the temperature difference

between channel 1 and channel 2.

- TEMP UNIT Options: °C and °F
- CONFIG >> You can select this option to access the TEMP CONFIG menu, in which you may select FACTORY CONFIG or USER CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

Temperature alarm limits:

Parameter	Upper Limit	Lower Limit	Step
T1 and T2	(lower limit+1) ~50	0~(upper limit-1)	0.1
TD	(lower limit+1) ~50	0~(upper limit-1)	0.1

Temperature alarm limits in factory configuration:

T1/T2 alarm high limit: 39°C

T1/T2 alarm low limit: 36°C

TD alarm limit: 2.0°C

13.4 Maintenance and Cleaning

WARNING

- Before cleaning the monitor or the probe, make sure the equipment is turned off and disconnected from AC power.
-
-

Reusable Temperature Probes

- The temperature probe should not be heated to a temperature over 100°C (212°F). It is only able to bear the temperature between 80 and 100°C (176 to 212°F) for a short time.
- The probe must not be disinfected in steam.
- Only detergents containing alcohol can be used for disinfection.
- The rectal probes should be used, if possible, in conjunction with a protective rubber cover.
- To clean the probe, hold the tip with one hand and with the other hand rub the probe down in the direction of the connector using a moist lint-free cloth.

NOTE

-
- Disposable temperature probes must not be re-sterilized or reused.
 - Disposable temperature probes must be recycled or disposed of properly.
-

14 IBP Monitoring

14.1 Overview

The monitor provides two channels to measure the invasive blood pressure (IBP, including diastolic, systolic and mean pressures), and displays two waveforms.

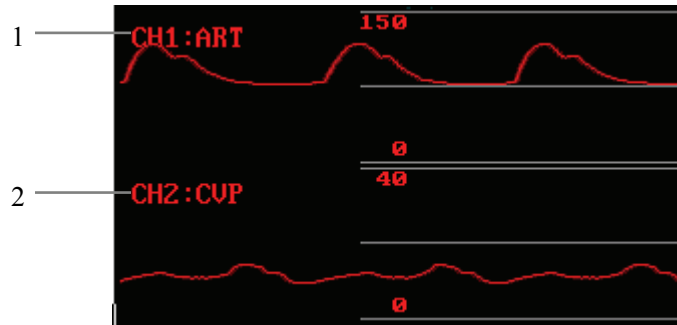


Figure 14-1 IBP Waveform

1. CH1 label: select the waveform of channel 1 to be displayed.
2. CH2 label: select the waveform of channel 2 to be displayed.

Options for CH1 and CH2: ART (Arterial Blood Pressure), PA (Pulmonary Arterial Pressure), CVP (Center Venous Pressure), RAP (Right Atrial Pressure), LAP (Left Atrial Pressure), ICP (Intracranial Pressure) and P1-P2 (Expand Pressure).

Besides, each waveform is followed by three scale lines, among which the upper and the lower ones are marked by scales on the left.

The parameter window locates to the right of the IBP waveforms as shown below.



Figure 14-2 IBP Parameter Window

1. IBP (1,2) label: This label allows you to access the IBP (1,2) SELECT menu.
2. Pressure unit: mmHg, kPa or cmH₂O.
3. Parameter values of channel 1: Systolic pressure, mean pressure and diastolic pressure (from the left to the right).
4. Parameter values of channel 2: Systolic pressure, mean pressure and diastolic pressure (from the left to the right). When ART or ICP is selected for CH1 and CH2 respectively, the ICP and CPP values will be displayed, where CPP is equal to the mean pressure of ART minus ICP.
5. PR numeric

14.2 Precautions

WARNING

- **Use only the IBP transducer specified in this operation manual. Disposable IBP transducers or domes should not be reused.**
 - **Parts and accessories used must meet the safety requirements of the medical electrical equipment standards.**
 - **The need for the operator to avoid conductive connection to the applied part likely to degrade safety. (For example, by not contacting metal cocks, if used.)**
 - **When the monitor is used with high frequency surgical equipment, do not allow the transducer and the cable contact the high frequency surgical equipment to prevent the patient from burning caused by leakage current.**
 - **Verify transducer cable fault detection before beginning to monitor. Unplug the transducer cable from the IBP connector on the monitor. The screen will display the error message “IBP SENSOR OFF” and an audible alarm will be heard.**
-

The transducer (except for the ICT/B transducer) specified in this operation manual is able to protect against electrical shock, especially the leakage current, and the interference of cardiac defibrillation. It can be used in surgical operation. During defibrillation, the pressure waveform might become temporarily distorted. However, the monitor returns to normal operation after the defibrillation, with the operation mode and the user configuration being unaffected.

NOTE

- **Periodically calibrate the transducer according to the Hospital Regulation.**
-

14.3 Monitoring Procedure

1. Plug the pressure cable into the IBP connector on the monitor and power on the monitor.
2. Prepare the pressure line and transducer by flushing the system with normal saline solution. Make sure the tubing and transducer system is free of air bubbles.

NOTE

-
- **In case of any entrapped air in the pressure system, re-fill the system with normal saline.**
-

3. Connect the catheter to the pressure line, making sure there is no air present in the catheter or pressure line.
4. Position the transducer so it is at the same level with the patient's heart, approximately mid-axillary line.
5. Verify the correct label is selected.
6. Zero the transducer.

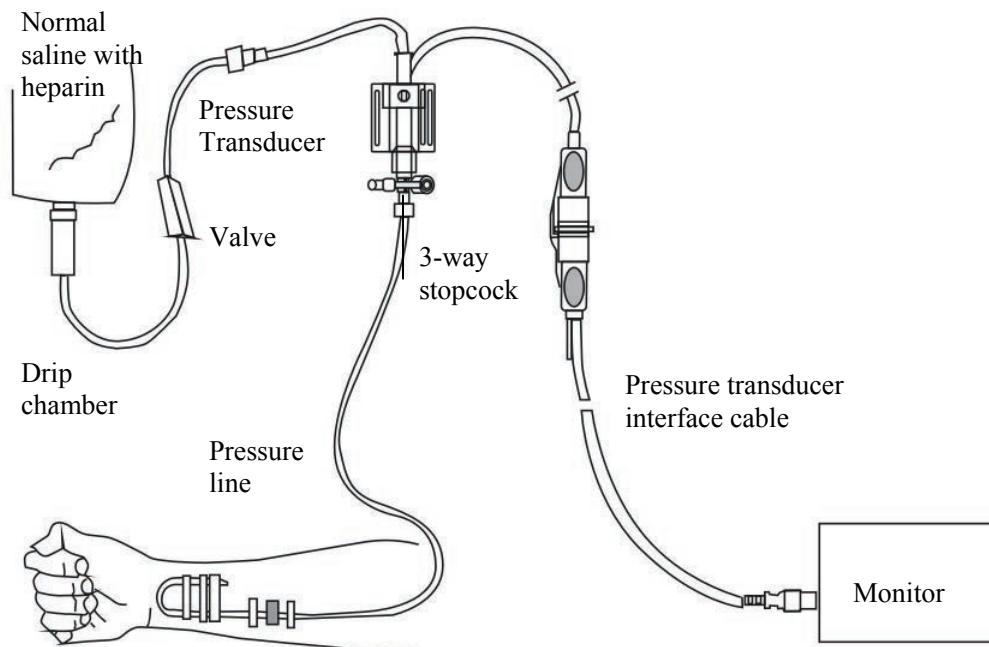


Figure 14-3 IBP Monitoring

14.4 IBP Menu

Selecting the IBP (1,2) label in the parameter window opens the following menu.

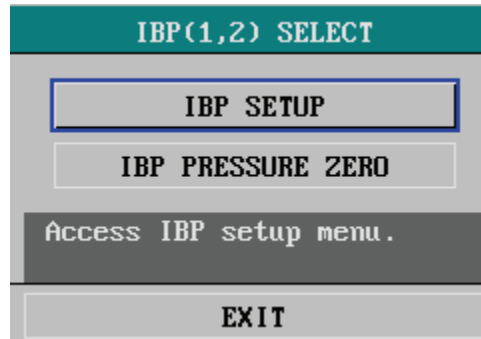


Figure 14-4 IBP (1,2) Select Menu

14.4.1 IBP Setup Menu

The IBP SETUP in IBP (1,2) SELECT menu allows you to access the following menu.

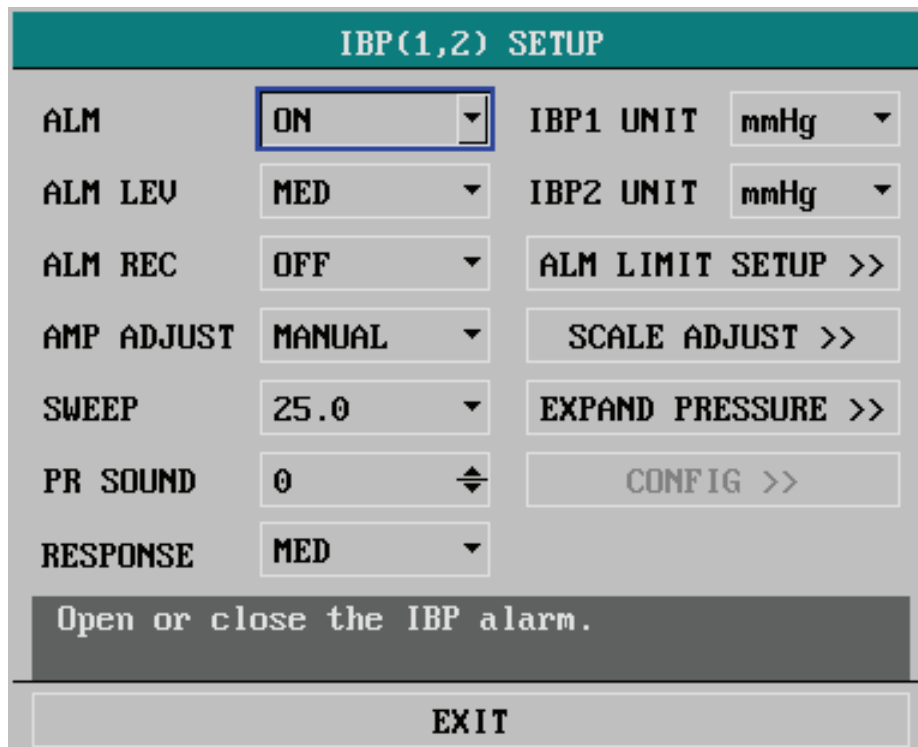



Figure 14-5 IBP (1,2) Setup Menu

You can perform the following settings in this menu.

- **ALM** IBP alarm on/off status
ON: When a IBP alarm occurs, the monitor gives alarm indications and stores the alarm;
OFF: When a IBP alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
When OFF is selected, the  icon is displayed on the right of the IBP (1,2) label.
- **ALM LEV** Alarm level
Options: HIGH, MED and LOW.
- **AMP ADJUST** Amplitude adjustment
This option allows you to adjust the waveform amplitude.
Options: MANUAL and AUTO.
 1. **MANUAL**: If MANUAL is selected, you can select an IBP channel manually from the options, including ART, PA, CVP, RAP, LAP, ICP, P1 and P2, and then adjust the IBP scale in the SCALE ADJUST >> menu.
 2. **AUTO**: If AUTO is selected, the waveform labels of IBP channels become P1 and P2 and the IBP scale is adjusted by the system automatically.
- **SWEEP** Waveform speed
Options: 12.5 and 25.0 mm/s.
- **PR SOUND** Pulse volume
Range: 0 - 10. 0 indicates the volume is closed and 10 indicates the maximum volume.
- **RESPONSE** Options: HIGH, MED and LOW.
The corresponding averaging time is about 1 s, 8 s and 12 s respectively.

The IBP value displayed on the monitor screen is the average of data collected within a specific time. The shorter the averaging time is, the quicker the patient monitor responds to changes in the patient's blood pressure. Contrarily, the longer the averaging time is, the slower the patient monitor responds to changes in the patient's blood pressure, but the measurement accuracy will be improved. For critically ill patients, selecting shorter averaging time will help understanding the patient's state.

- **IBP1 UNIT** Options: mmHg, kPa and cmH2O.
- **IBP2 UNIT** Options: mmHg, kPa and cmH2O.
- **ALM LIMIT SETUP >>** This option allows you to access the following menu, whereby you can set the upper and lower alarm limits.

IBP ALM LIMIT SETUP				
	SYS	MEAN	DIA	
CH1:ART ALM HI	160	110	90	mmHg
CH1:ART ALM LO	90	70	50	mmHg
CH2:CVP ALM HI	---	10	---	mmHg
CH2:CVP ALM LO	---	0	---	mmHg
PR ALM HI	120	PR ALM LO	50	

Set upper limit of IBP systolic pressure. If above upper limit, alarms occurs.

EXIT

Figure 14-6 IBP Alarm Setup Menu

IBP alarm limits

Pressure Label	Upper Limit (mmHg)	Lower Limit (mmHg)	Step (mmHg)
ART	(lower limit+2) ~300	0~(upper limit-2)	1
PA	(lower limit+2) ~120	-6~(upper limit-2)	1
CVP	(lower limit+2) ~40	-10~(upper limit-2)	1
RAP	(lower limit+2) ~40	-10~(upper limit-2)	1
LAP	(lower limit+2) ~40	-10~(upper limit-2)	1
ICP	(lower limit+2) ~40	-10~(upper limit-2)	1
P1	(lower limit+2) ~300	-50~(upper limit-2)	1
P2	(lower limit+2) ~300	-50~(upper limit-2)	1

The PR alarm limits are the same as those of the corresponding SpO₂ module.

- SCALE ADJUST >> This option allows you to open the following menu and set the positions of the high, reference and low scales for the two waveforms.

IBP SCALE ADJUST				
	HI	LO	VAL	
CH1:ART	150	0	75	mmHg
CH2:CVP	40	0	20	mmHg

Adjust the value of the upper scale (the upper line).

EXIT

Figure 14-7 IBP Scale Adjust Menu

-
1. HI: Determines the high scale. The reference scale changes when the high scale is changed.
 2. LO: Determines the low scale. The reference scale changes when the low scale is changed.
 3. VAL: Determines the reference scale and position. The high and low scales remain unchanged when the reference scale is changed.

NOTE

-
- **The high scale should not be smaller than the low scale; the low scale should not be larger than the high scale.**
 - **The waveform amplitude changes when the high and low scales are adjusted.**
-

- **EXPAND PRESSURE** Selecting this option opens the following menu. You can select the pressure to be measured by P1 and P2.
Options: SYS, MEAN, DIA (three pressures are all measured); MEAN (only the mean pressure is measured).

The screenshot shows a menu titled "IBP EXPAND PRESSURE". It has two dropdown menus: "P1 SELECT:" and "P2 SELECT:", both currently displaying "SYS,MEAN,DIA". Below these is a text prompt: "Select the pressure name to be represented by P1." At the bottom of the menu is an "EXIT" button.

Figure 14-8 IBP Pressure Setup Menu

- **CONFIG >>** You can select this option to access the IBP (1,2) CONFIG menu, in which you may select FACTORY CONFIG or USER CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

14.4.2 IBP Pressure Zero Menu

You can select IBP PRESSURE ZERO in IBP (1,2) SELECT menu to open the following menu.

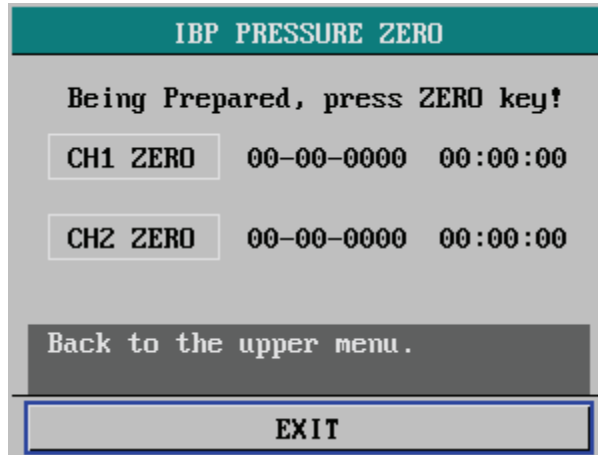


Figure 14-9 IBP Pressure Zero Menu

Pressure Transducer Zeroing Procedure

1. Disconnect the transducer from the patient.

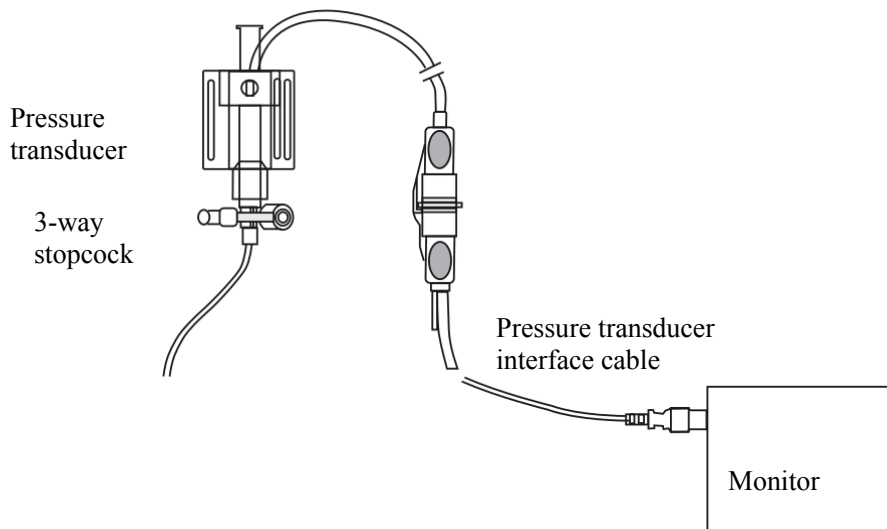


Figure 14-10 Pressure Transducer Zeroing

2. Adjust the 3-way stopcock to close the channel leading to the patient. The transducer is open to the atmosphere through the stopcock.
3. Select CH1 ZERO or CH2 ZERO in IBP PRESSURE ZERO menu to start zeroing.

NOTE

- **To ensure correct measurement, zero the transducer before it is used to zero the monitor.**
 - **Position the transducer at the same level with the patient's heart, approximately mid-axillary line.**
 - **Perform the pressure zeroing before monitoring, and at intervals during monitoring (at least once per day). The zeroing should also be conducted once the transducer cable is disconnected and then connected.**
-

Prompt Information Related to Zeroing

Take channel 1 as an example. The monitor may give the following prompt information after the pressure transducer zeroing has been finished.

■ **CH1 SUCCESSFUL ZERO**

The zeroing procedure is over. The transducer port opening to the atmosphere is to be closed and the port connecting to the patient opened.

■ **CH1 SENSOR OFF, FAIL**

Verify the transducer of channel 1 is connected to the monitor, and then perform zeroing again. If the monitor continues to give this prompt information, contact our Customer Service.

■ **IN DEMO, FAIL**

Make sure the monitor is not in DEMO mode, and perform pressure transducer zeroing again. If the monitor continues to give this prompt information, contact our Customer Service.

■ **PRESSURE OVER RANGE, FAIL**

Verify the 3-way stopcock is open to the atmosphere, and perform the pressure transducer zeroing again. If the prompt information is still displayed, change with a new transducer and contact our Customer Service.

■ **PULSATILE PRESSURE, FAIL**

Make sure the transducer is not connected to the patient and the stopcock is open to the atmosphere. Then, perform the pressure transducer zeroing once again. If the prompt is still displayed, contact our Customer Service.

14.5 Maintenance and Cleaning

WARNING

- **Before cleaning the transducer, make sure the transducer is disconnected from the monitor, or the monitor is powered off and disconnected from AC power.**
-

Cleaning of IBP Transducer

After the IBP monitoring operation is completed, remove the tubing and the dome from the transducer and wipe the transducer diaphragm with water. To clean the transducer and the cable, wipe them using soap or the detergents listed below:

- Cetylcide
- Wavicide-01
- Wescodyne
- Cidex
- Lysol
- Vesphene

Do not immerse the connector in any liquid. After cleaning, dry the transducer thoroughly before storing. Slight discoloration or temporary increase of surface stickiness of the cable should not be considered abnormal. If it is necessary to remove the adhesive tape residue from the transducer cable, the double seal tape remover is recommended; use the remover with special caution to minimize the damage to the cable. Acetone, Alcohol, Ammonia and Chloroform, or other strong solvents are not recommended because they are harmful to the vinyl cabling if used for a long time.

NOTE

- **The disposable transducers or domes must not be reused.**
 - **To avoid contamination, the disposable transducers or domes must be reclaimed or disposed of properly.**
-

Sterilization

■ Chemical Solution Sterilization

After finishing the cleaning, select an effective sterilant for chemical solution sterilization of the operating room equipment. Buffered glutaraldehyde (e.g. Cidex or Hospisept) is recommended. Do not use quaternary cationic detergents such as zephiran chloride. If the whole unit is to be sterilized, immerse the transducer but not the electrical connector into the sterilant for the recommended sterilizing period. Ensure that the dome has been removed. Then rinse all transducer parts except the electrical connector with sterilized water or saline. The transducer must be thoroughly dried before storing.

■ Gas Sterilization

For more complete asepsis, use gas sterilization. The transducer should be completely dry after cleaning. When ethylene oxide gas is used as the gas disinfectant, follow the operating instructions provided by the manufacturer of the gas disinfectant.

NOTE

-
- **The disinfectant temperature must not exceed 70°C (158°F). Plastics in the pressure transducer may deform or melt above this temperature.**
-

FOR YOUR NOTES

15 CO₂ Monitoring

15.1 Overview

The monitor is able to measure the CO₂ pressure of the patient airway, and displays the CO₂ waveform in the waveforms area of the monitor screen. The CO₂ parameter window shows the following parameters:

- End-tidal CO₂ concentration (EtCO₂)
- Inspired Minimum CO₂ (InsCO₂)
- Air Way Respiration Rate (AwRR)

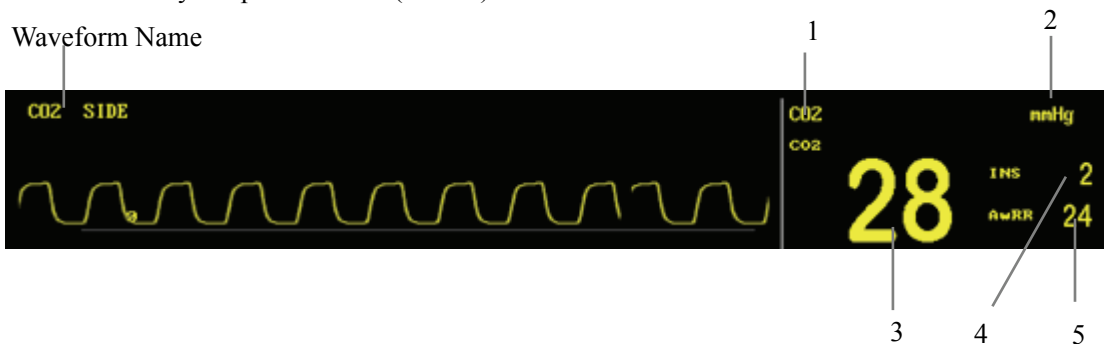


Figure 15-1 CO₂ Waveform and Parameters

1. CO₂ label: This option allows you to access the CO₂ SETUP menu.
2. Pressure unit: mmHg or kPa.
3. EtCO₂: The measured value of EtCO₂.
4. InsCO₂: The measured value of InsCO₂.
5. AwRR: The measured value of AwRR.

Adverse effects on stated performance may occur as a result of the following:

- Leaks or internal venting of sampled gas;
- Mechanical shock;
- Cyclic pressure up to 10 kPa (100 cmH₂O);
- Other sources of interference, if any.

NOTE

- CO₂ and CO₂ are used interchangeably in this chapter.
- The sidestream and microstream CO₂ module is equipped with automatic barometric pressure compensation.

15.2 Mindray DS CO₂ Module

NOTE

-
- This section is only applicable to a monitor equipped with a Mindray DS CO₂ module.
-

15.2.1 Principles of Operation

WARNING

- The CO₂ module should be protected against crash and vibration.
 - This CO₂ module is applicable to neonate, pediatric as well as adult patients.
 - Inaccurate measurement may occur when the monitor is operating in an environment of excessively high CO₂ content (>0.5%).
-

The monitor adopts sidestream CO₂ module. The measurement of this module is based on the feature that the CO₂ molecule absorbs infrared ray. The measurement procedure is as follows : send the CO₂ to a measurement chamber inside the module through the airway system, and then irradiate 4.26um infrared ray at one side of the chamber and use the sensor to measure the attenuation degree of the received infrared ray at the other side. Since the attenuation degree of the infrared ray is proportional to the concentration of CO₂, the CO₂ concentration is calculated. The measured CO₂ concentration is thereafter converted into the partial pressure under the same temperature and pressure, and then displayed.

The relation between the partial pressure and the CO₂ concentration is given below:

CO₂ partial pressure (mmHg)=

CO₂ concentration (%)×Pamp (ambient pressure, mmHg)/100

CO₂ partial pressure (kPa)= CO₂ partial pressure (mmHg)/7.5

15.2.2 Preparations for CO₂ Measurement

1. Plug the water trap into its receptacle before the measurement.
2. Open the CO₂ SETUP menu and set WORK MODE to MEASURE. The “CO₂ START UP” prompt information is displayed on the screen until the startup is finished.
3. After the module start-up, the “CO₂ WARM UP” prompt information is displayed on the screen. At this time, the module is in the Warming-up status.
4. After the module warm-up, the module enters the Ready-to-measure status.

When the monitor is powered on for the first time, the CO₂ module enters the STANDBY mode by default. To activate the CO₂ module, you must change the work mode to MEASURE. The work mode of the CO₂ module keeps unchanged when the monitor is restarted. For instance, if the monitor is power off when the CO₂ module is working in the MEASURE mode, the CO₂ module will automatically enter the MEASURE mode after the monitor is restarted. For details about WORK MODE, please refer to the section *Other Setup* in 15.2.3CO₂ .



Figure 15-2 CO₂ Module Airway Connections

The measure CO₂ concentration can be compensated in two ways:

- ATPD (Ambient Temperature and Pressure, Dry Gas);
- BTPS (Body temperature and pressure, Saturated);

ATPD means the CO₂ value is measured in ambient temperature and pressure and dry gas, while BTPS means the CO₂ is measured at a temperature of 37°C, a relative humidity of 95% and a 47mmHg (pH₂O) partial pressure of moisture.

The calculation formulas in the above two compensations are as follows:

ATPD: PCO_2 (mmHg) = CO_2 (vol%) × Pamp/100

BTPS: PCO_2 (mmHg) = CO_2 (vol%) × (Pamp-47)/100

In the above formulas, PCO_2 refers to the CO_2 partial pressure, vol% is the percentage of the gas concentration, and Pamp is the ambient pressure in the unit of mmHg.

WARNING

- Do not use the accessory if the packaging or the internal accessory is damaged. Return it to the manufacturer.
 - “CO2 START UP” and “CO2 WARM UP” displayed on the screen indicate that the sensor is starting up and warming up. During the warming up, the module can measure CO2, but the measurement is not standard. After the above information disappears, the standard measurement can be performed.
 - The sidestream sampling line is disposable. It should not be disinfected for reuse or cross-used by different patients.
 - The water trap is used to collect water drops condensed in the sampling airway and prevent water drops from entering the module. When the collected water reaches to a certain amount, remove the water to avoid blocking the airway.
 - In the long-term use, dust or other substances may lower the air permeability of the filter material in the water trap and may block the airway. In this situation, the water trap must be replaced.
-

15.2.3 CO₂ Setup Menu


Selecting the CO₂ label in the parameter window opens the following menu.



CO2 SETUP			
ALM	ON	AWRR ALM LO	8
ALM LEV	MED	APNEA ALM	20S
ALM REC	OFF	SWEEP	6.25
CO2 ALM HI	50	UNIT	mmHg
CO2 ALM LO	15	WAVE SCALE	LOW
INS ALM HI	4	WORK MODE	STANDBY
AWRR ALM HI	30	OTHER SETUP >>	
Open or close the CO2 alarm.			
EXIT			

Figure 15-3 CO₂ Setup Menu

You can perform the following settings in this menu.

- **ALM** Alarm on/off status
ON: When a CO2 alarm occurs, the monitor gives alarm indications and stores the alarm;
OFF: When a CO2 alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
When OFF is selected, the  icon is displayed on the right of the CO2 label.
- **ALM LEV** Alarm level
Options: HIGH and MED.
- **ALM REC** Alarm recording
ON: When a CO2 alarm occurs, the monitor enables the recording;
OFF: When a CO2 alarm occurs, the monitor does not enable the recording.
- **CO2 ALM HI** Upper alarm limit of EtCO2
- **CO2 ALM LO** Lower alarm limit of EtCO2
- **INS ALM HI** Upper alarm limit of InsCO2
- **AWRR ALM HI** Upper alarm limit of AwRR
- **AWRR ALM LO** Lower alarm limit of AwRR
- **APNEA ALM** Determines the apnea alarm delay.
If the apnea of the patient exceeds the preset apnea alarm delay, the monitor triggers an alarm and gives the " CO2 APNEA " alarm message.
Options: 10S, 15S, 20S, 25S, 30S, 35S and 40S.
- **SWEEP** Waveform speed
Options: 6.25, 12.5 and 25.0.
Unit: mm/s.
- **UNIT** Options: mmHg, kPa and %.
- **WAVE SCALE** Options: HIGH and LOW.
This option allows you to adjust the amplitude of the CO2 waveform.
- **WORK MODE** Options: MEASURE and STANDBY.
To start the CO2 monitoring, select the MEASURE mode.
In the STANDBY mode, the air pump and infrared ray source of the CO2 module are disabled. Hence, decreases the power consumption and prolongs the operating life of infrared ray source and the whole CO2 module.

Alarm limits:

Parameter	Upper Limit	Lower Limit	Step
CO2	(lower limit+2) ~100	0~(upper limit-2)	1
INS	0~100	/	1
AwRR	(lower limit+2) ~150	0~(upper limit-2)	1

Default alarm limits:

Parameter	Patient type	Upper limit	Lower limit
CO2	Adult	50	15
	Pediatric	50	20
	Neonate	45	30
INS	Adult	4	/
	Pediatric	4	/
	Neonate	4	/
AwRR	Adult	30	8
	Pediatric	30	8
	Neonate	100	30

NOTE

-
- The apnea alarm cannot be disabled.
 - When the CO2 monitoring is not required, it is recommended the water trap not be connected and the work mode be set to STANDBY.
-

Other Setup

Selecting OTHER SETUP option opens the following menu.

CO2 SETUP	
PUMP RATE	100ml/min
BTPS	ON
N2O COMPEN	0
O2 COMPEN	0
Des COMPEN	0
Adjust pumping rate of CO2 pump.	
EXIT	

Figure 15-4 CO₂ Other Setup Menu

You can perform the following settings in this menu.

- PUMP RATE Determines the sampling rate of the CO₂ module pump.
- N2O COMPEN N2O compensation
The presence of nitrous oxide causes the CO₂ value to be higher than the actual value. Use this option to compensate for the presence of N₂O.
- O2 COMPEN O2 compensation
The presence of a large concentration of oxygen causes the CO₂ value to be lower than the actual value. Use this option to compensate for the presence of O₂.
- Des COMPEN Desflurane compensation
The presence of desflurane causes the CO₂ value to be higher than the actual value. Use this option to compensate for the presence of desflurane.

NOTE

-
- The unit of N2O COMPEN, O2 COMPEN and Des COMPEN is “%”. The concentration of N2O, O2 and Desflurane can be obtained from the anesthesia machine.
 - Set the N2O COMPEN, O2 COMPEN and Des COMPEN according to the practical situation. Incorrect setting might incur errors from the actual value and cause misdiagnosis.
-

- BTPS Body Temperature and Pressure, Saturated
Options: ON and OFF.

When BTPS is turned ON, the system performs BTPS compensation automatically; when BTPS is turned OFF, the BTPS compensation is disabled.

When measuring the CO₂ content inside the patient's lung, turn ON BTPS. Normally, the lung temperature of the patient is 37°C and the water vapor is sufficient or regarded as saturated. But the temperature and water vapor content of the sampling line are different from the patient's exhalation. Thus, when the patient's exhalation passes the sampling line, the accuracy of the CO₂ concentration measured by the sensor will be adversely affected. To ensure an accurate measurement, you should turn ON the BTPS. In this mode, the system adjusts the calculation coefficient automatically, so that the measured value is just the actual CO₂ content in the patient's lung.

When measuring the CO₂ content of the environment or a certain vessel, turn OFF BTPS. In the standard ambient pressure and dry gas, the accuracy of the sensor measurement is not affected.

NOTE

- **When measuring a moist gas of saturated water vapor at the body temperature and the ambient pressure, turn ON BTPS; when measuring a dry gas at the ambient temperature and pressure, turn OFF BTPS.**
-

- ZERO CAL This option allows you to zero manually so as to eliminate the adverse affect of baseline drift in the process of measurement.
- CONFIG >> Select CONFIG >> to access the CO2 CONFIG menu. You can select either FACTORY CONF or USER CONF. After finishing the selection and exiting the menu, a dialog pops up asking for confirmation of your selection.

15.2.4 CO₂ User Maintain Menu

Select CO2 USER MAINTAIN >> in USER MAINTAIN menu. The following menu appears.

The screenshot shows a menu titled "CO2 USER MAINTAIN" with a teal header. Below the header, there are several rows of data and controls:

- CO2**: 0.00, followed by a dropdown menu showing "3" and a percentage sign (%).
- BAROMETRIC**: 750 mmHg
- SENSOR TEMP**: 0 °C
- CUR PUMP RATE**: 0 ml/min
- SET PUMP RATE**: 100ml/min

Below these rows are two buttons: "ZERO CAL" and "CONFIRM CAL". At the bottom of the menu is a large button labeled "EXIT". A dark grey box at the bottom of the menu contains the text: "Setup the CO2 concentration of user calibration."

Figure 15-5 CO₂ User Maintain Menu

The following information is displayed in the menu above.

- **CO2** The currently measured CO2 content.
Unit: %.

In the field at the right of the CO₂ value, you can select a standard gas containing a certain amount of CO₂ for calibration.

Options: 3%, 4%, 5%, 6% and 7%.

- **BAROMETRIC** The currently measured barometric pressure.
Unit: mmHg.
- **SENSOR TEMP** The currently measured temperature around the infrared sensor.
Unit: °C.
- **CUR PUMP RATE** The currently measured pumping rate.
Unit: ml/min.
- **SET PUMP RATE** The sampling flow rate set by the user.
- **ZERO CAL** This option allows you to zero the CO2 module, so as to eliminate the adverse affect of the baseline drift in the process of measurement. Perform zeroing prior to concentration calibration.

-
- **CONFIRM CAL** This option allows you to confirm the calibration of the CO2 module.

Calibration Procedure

1. Verify the module enters the ready-to-measure status.
2. Connect a gas bottle with the CO2 sensor connector on the monitor as shown below.

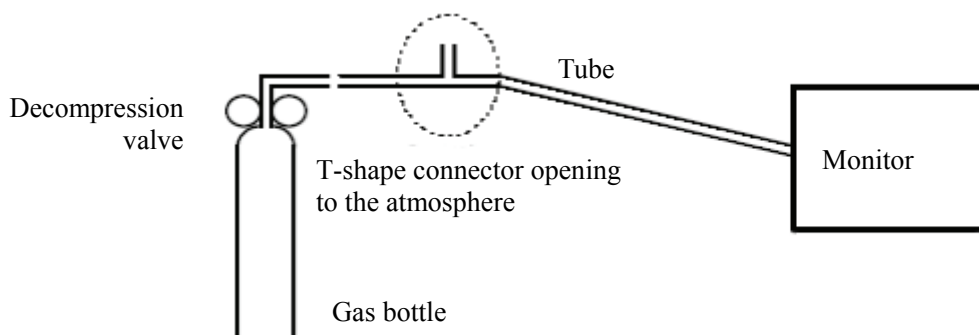


Figure 15-6 Connections for Calibration

3. Fill the gas bottle with a standard gas of certain CO2 content (3%, 4%, 5%, 6% and 7%), and input the gas to the monitor.
4. Open the CO2 USER MAINTAIN menu, and set the CO2 field to a value, which is the same with the CO2 content of the gas bottle.
5. When the CO2 USER MAINTAIN menu displays the currently measured CO2 content, wait until a stable reading is indicated, and then select the CONFIRM CAL option to start calibrating the CO2 module.
6. If the calibration succeeds, “CALIBRATE SUCCESS!” will be displayed in the CO2 USER MAINTAIN menu. If fails, “CAL FAIL, TRY AGAIN!” will be displayed, and re-calibration is required.
7. Select the EXIT option to exit the CO2 USER MAINTAIN menu.

15.2.5 Maintenance and Cleaning

- The sampling line of the sidestream CO2 module is disposable and cannot be disinfected for reuse.
- In case of an exception in the sampling system of the CO2 module, check for entanglement of the sampling line. If the sampling line is not entangled, remove it from the water trap. In this situation, if the screen displays a prompt information indicating the CO2 sampling line is abnormal, the water trap must have been blocked, and you must replace it with a new one. If no prompt information is given, the sampling line must have been blocked, and you should replace with a new sampling line.
- Routine calibration of the sidestream CO2 module is not required. But the calibration must be performed every year, or when great inaccuracy of measurement is found.

15.3 Oridion CO₂ Module

NOTE

-
- This section is applicable to a monitor equipped with the Oridion CO₂ module only.
 - When the sample flow is lower than 42.5 ml/min, alarm message will be displayed, and the CO₂ module will stop work.
-

15.3.1 Principles of Operation

WARNING

- The CO₂ module should be protected against crash and vibration.
 - This CO₂ module is applicable to neonate, pediatric as well as adult patients.
 - Inaccurate measurement may occur when the monitor is operating in an environment of excessively high CO₂ content (>0.5%).
-

The monitor adopts Oridion (microstream) CO₂ module. The measurement of this module is based on the feature that the CO₂ molecule absorbs infrared ray. The measurement procedure is as follows : send the CO₂ to a measurement chamber inside the module through the airway system, and then irradiate 4.26um infrared ray at one side of the chamber and use the sensor to measure the attenuation degree of the received infrared ray at the other side. Since the attenuation degree of the infrared ray is proportional to the concentration of CO₂, the CO₂ concentration is calculated. The measured CO₂ concentration is thereafter converted into the partial pressure under the same temperature and pressure, and then displayed.

The relation between the partial pressure and the CO₂ concentration is given below:

CO₂ partial pressure (mmHg)=

CO₂ concentration (%)×Pamp (ambient pressure, mmHg)/100

CO₂ partial pressure (kPa)= CO₂ partial pressure (mmHg)/7.5

15.3.2 Preparations for CO₂ Measurement

1. Plug the sampling line into its receptacle before the measurement.
2. Open the CO₂ SETUP menu and set WORK MODE to MEASURE.
3. The “CO₂ START UP” prompt information is displayed on the screen until the startup is finished.

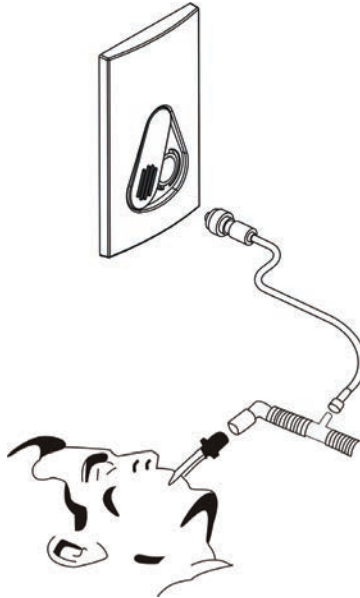


Figure 15-7 CO₂ Module Airway Connections

When the monitor is powered on for the first time, the CO₂ module enters the STANDBY mode by default. To activate the CO₂ module, you must change the work mode to MEASURE. The work mode of the CO₂ module keeps unchanged when the monitor is restarted. For instance, if the monitor is power off when the CO₂ module is working in the MEASURE mode, the CO₂ module will automatically enter the MEASURE mode after the monitor is restarted. For details about WORK MODE, please refer to the section *15.3.3CO₂* .

WARNING

- **Do not use the accessory if the packaging or the internal accessory is damaged. Return it to the manufacturer.**
 - **The sidestream sampling line is disposable. It should not be disinfected for reuse or cross-used by different patients.**
-

15.3.3 CO₂ Setup Menu


Selecting the CO₂ label in the parameter window opens the following menu.

CO2 SETUP			
ALM	ON	AWRR ALM LO	8
ALM LEV	MED	APNEA ALM	20S
ALM REC	OFF	SWEEP	6.25
CO2 ALM HI	50	UNIT	mmHg
CO2 ALM LO	15	WAVE SCALE	LOW
INS ALM HI	4	WORK MODE	STANDBY
AWRR ALM HI	30	OTHER SETUP >>	
Open or close the CO2 alarm.			
EXIT			

Figure 15-8 CO₂ Setup Menu

You can perform the following settings in this menu.

- ALM Alarm on/off status
ON: When a CO₂ alarm occurs, the monitor gives alarm indications and stores the alarm;
OFF: When a CO₂ alarm occurs, the monitor neither gives alarm indications nor stores the alarm;

When OFF is selected, the  icon is displayed on the right of the CO₂ label.
- ALM LEV Alarm level
Options: HIGH and MED.
- ALM REC Alarm recording
ON: When a CO₂ alarm occurs, the monitor enables the recording;
OFF: When a CO₂ alarm occurs, the monitor does not enable the recording.
- CO₂ ALM HI Upper alarm limit of EtCO₂
- CO₂ ALM LO Lower alarm limit of EtCO₂
- INS ALM HI Upper alarm limit of InsCO₂
- AWRR ALM HI Upper alarm limit of AwRR

- **AWRR ALM LO** Lower alarm limit of AwRR

- **APNEA ALM** Determines the apnea alarm delay.
 If the apnea of the patient exceeds the preset apnea alarm delay, the monitor triggers an alarm and gives the “CO2 APNEA” alarm message.
 Options: 10S, 15S, 20S, 25S, 30S, 35S and 40S.

- **SWEEP** Waveform speed
 Options: 6.25, 12.5 and 25.0.
 Unit: mm/s.

- **UNIT** Options: mmHg, kPa And %.

- **WAVE SCALE** Options: HIGH and LOW.
 This option allows you to adjust the amplitude of the CO2 waveform.

- **WORK MODE** Options: MEASURE and STANDBY.
 To start the CO2 monitoring, select the MEASURE mode.
 In the STANDBY mode, the air pump and infrared ray source of the CO2 module are disabled. Hence, decreases the power consumption and prolongs the operating life of infrared ray source and the whole CO2 module.

NOTE

- **When the CO2 monitoring is not required, it is recommended the work mode be set to STANDBY.**

Other Setup

Selecting the OTHER SETUP option opens the following menu.

The screenshot shows a menu titled "CO2 SETUP" with a teal header. Below the header, there are three rows of settings, each with a label, a value, and a dropdown arrow:

- MAX HOLD**: 20S
- BTPS**: ON
- AUTO STANDBY**: 0 min

To the right of these settings are two buttons: "ZERO CAL" and "CONFIG >>". At the bottom of the menu, there is a button labeled "EXIT". A dark grey bar at the bottom of the menu contains the text "Back to the upper menu."

Figure 15-9 CO₂ Other Setup Menu

You can perform the following settings in this menu.

- **MAX HOLD** If Max Hold is configured to 10 sec or 20 sec, the etCO₂ numeric shows the highest CO₂ value measured within the previous 10 or 20 seconds. If set to Off the etCO₂ numeric shows breath-to-breath value.
- **BTPS** Body temperature and pressure, Saturated
Options: ON and OFF.

When BTPS is turned ON, the system performs BTPS compensation automatically; when BTPS is turned OFF, the BTPS compensation is disabled.

When measuring the CO₂ content inside the patient's lung, turn ON BTPS. Normally, the lung temperature of the patient is 37°C and the water vapor is sufficient or regarded as saturated. But the temperature and water vapor content of the sampling line are different from the patient's exhalation. Thus, when the patient's exhalation passes the sampling line, the accuracy of the CO₂ concentration measured by the sensor will be adversely affected. To ensure an accurate measurement, you should turn ON the BTPS. In this mode, the system adjusts the calculation coefficient automatically, so that the measured value is just the actual CO₂ content in the patient's lung.

When measuring the CO₂ content of the environment or a certain vessel, turn OFF BTPS. In the standard ambient pressure and dry gas, the accuracy of the sensor measurement is not affected.

NOTE

-
- **When measuring a moist gas of saturated water vapor at the body temperature and the ambient pressure, turn ON BTPS; when measuring a dry gas at the ambient temperature and pressure, turn OFF BTPS.**
-

- **AUTO STANDBY** Range: 0 to 60min.
If no respiration waveform is detected in the selected time, the CO₂ module enters the standby mode automatically.
When AUTO STANDBY is set to 0min, it means the CO₂ module is in MEASURE state. If the sampling line is not connected, the CO₂ module enters the standby mode automatically 3 minutes later.
- **ZERO CAL** This option allows you to zero manually so as to eliminate the adverse affect of baseline drift in the process of measurement.
- **CONFIG >>** Select CONFIG >> to access the CO₂ CONFIG menu.
You can select either FACTORY CONF or USER CONF.
After finishing the selection and exiting the menu, a dialog pops up asking for confirmation of your selection.

15.3.4 CO₂ User Maintain Menu

Select CO₂ USER MAINTAIN >> in USER MAINTAIN menu. The following menu appears.



Figure 15-10 CO₂ User Maintain Menu

The following information is displayed in the menu above.

- CO₂ The currently measured CO₂ content.
Unit: %.

In the field at the right of the CO₂ value, you can select a standard gas containing a certain amount of CO₂ for calibration.

- BAROMETRIC The currently measured barometric pressure.
Unit: mmHg.
- CONFIRM CAL This option allows you to confirm the calibration of the CO₂ module.

Calibration Procedure

1. Verify the module enters the Full Accuracy Mode.
2. Connect a gas bottle with the CO2 sensor connector on the monitor as shown below.

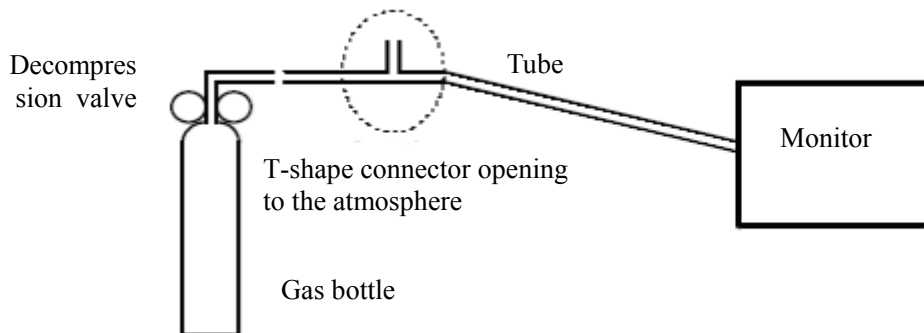


Figure 15-11 Connections for Calibration

3. Fill the gas bottle with a standard gas of certain CO2 content (4% to 6%), and input the gas to the monitor.
4. Open the CO2 USER MAINTAIN menu, and set the CO2 field to a value, which is the same with the CO2 content of the gas bottle.
5. When the CO2 USER MAINTAIN menu displays the currently measured CO2 content, wait until a stable reading is indicated, and then select the CONFIRM CAL option to start calibrating the CO2 module.
6. If the calibration succeeds, "CALIBRATE SUCCESS!" will be displayed in the CO2 USER MAINTAIN menu. If fails, "CAL FAIL, TRY AGAIN!" will be displayed, and re-calibration is required.
7. Select the EXIT option to exit the CO2 USER MAINTAIN menu.

15.3.5 Maintenance and Cleaning

- The sampling line of the micorstream CO2 module is disposable and cannot be disinfected for reuse.
- Routine calibration of the microstream CO2 module is not required. But the calibration must be performed if it is prompted in the CO2 USER MATINTAIN menu, or great inaccuracy of measurement is found.

15.3.6 Oridion Information

Microstream

This trademark is registered in Israel, Japan, Germany and US.

Oridion Patents

This device and the CO₂ sampling consumable designed for use herewith is covered by one or more of the following USA patents: 4,755,675; 5,300,859; 5,657,750; 5,857,461 and international equivalents. USA and international patents pending.

No Implied Licence

Possession or purchase of this device does not convey any express or implied license to use the device with unauthorized consumable CO₂ sampling consumable products which would, alone, or in combination with this device, fall within the scope of one or more of the patents relating to this device and/or CO₂ sampling consumable products.

15.4 Removing Exhaust Gases from the System

WARNING

- **Anesthetics:** When using the Sidestream or Microstream CO₂ measurement on patients who are receiving or have recently received anesthetics, connect the outlet to a scavenging system, or to the anesthesia machine/ventilator, to avoid exposing medical staff to anesthetics.
-

To remove the sample gas to a scavenging system, connect an exhaust tube to the gas outlet connector of the module.

16 Anesthesia Gas Monitoring

16.1 Overview

The anesthesia gas (AG) monitoring can be used for measuring the anesthesia gas and respiration gas of the patient in the anesthetic status. This monitor can configure AION 02 AG module or AION 03 AG module. AG module provides the end-tidal numerics and inhaling numerics of the gases mentioned below.

- Carbon dioxide (CO₂): The measured numeric is EtCO₂ (Max. exhaling value: Max. exhaling numeric detected during the respiration).
- Nitrous oxide (N₂O): Laughing gas.
- Oxygen (O₂): Optional function.
- Anesthetic (AA): Refers to the monitored anesthetic (DES, ISO, ENF, SEV or HAL).
- Airway respiration rate (AwRR): respiration per minute (BrPM).

The patient monitor can display simultaneously a maximum of 4 waveforms, including the CO₂ waveform (default waveform), N₂O waveform, O₂ waveform and the anesthetic (ENF: Enflurane) waveform.

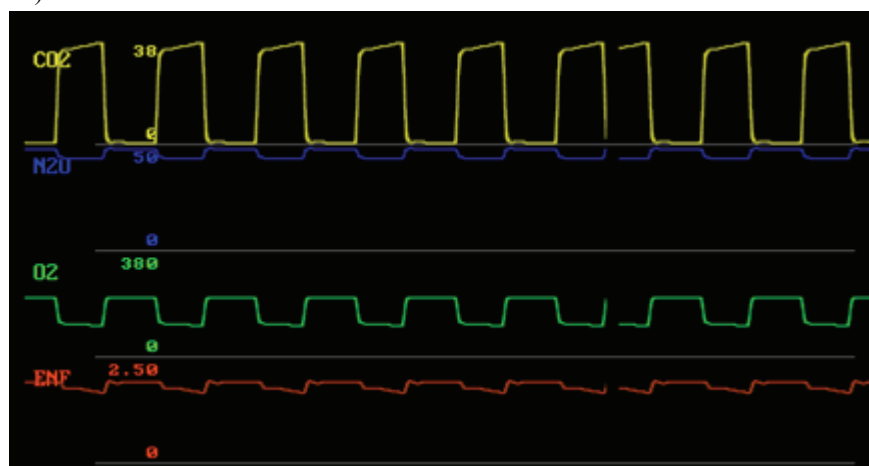


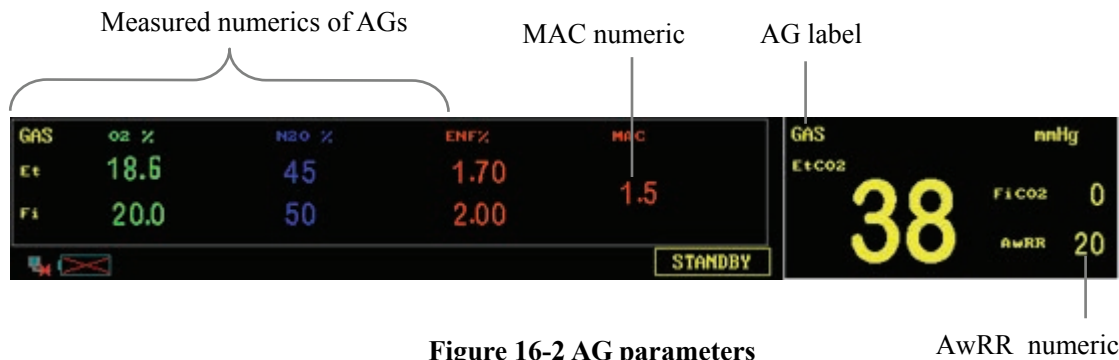
Figure 16-1 AG waveform

In addition, the patient monitor can display parameters, including CO₂, N₂O, O₂ and AA (Which refers to the monitored anesthetic: DES, ISO, ENF, SEV or HAL). It also displays the inhaling and exhaling numerics as well as MAC (Minimum Alveolar Concentration)/MAL (balance gas) and AwRR.

When the O₂ module is not connected, no O₂ waveform will be displayed. After the O₂ module is connected, whether the O₂ waveform is displayed depends on whether the O₂ waveform is switched on in the configuration. If there are too many waveforms to be displayed, the O₂ waveform will probably not be displayed.

Parameters:

- CO₂: Carbon dioxide
- N₂O: Nitrous oxide (laughing gas)
- O₂: Oxygen
- AwRR: Airway respiration rate (respiration per minute, BrPM)
- HAL: Halothame
- ISO: Isoflurane
- ENF: Enflurane
- SEV: Sevoflurane
- DES: Desflurane



NOTE

- The AG module is not intended to monitor multiple halogenated anaesthetic gases.
 - To avoid explosion hazard, do not use flammable anesthetic agent such as ether and cyclopropane for this equipment.
-

16.2 Measurement Principles and Procedure

Measurement principle of AGs

The AG concentration is measured based on the rationale that the AGs have the property of absorbing the infrared.

The AG module can measure gases that have various properties of absorbing the infrared. To measure the concentration of a gas, send it to the sampling room, select the infrared of a specific wavelength with an optical infrared filter, and transmit it through the gas. For a given volume of gas, the higher its concentration is, the more the infrared that will be absorbed by the gas is, and the less the infrared that will be transmitted through the gas is. The concentration of the measured gas is in inverse proportion to the volume of the infrared that is transmitted through the gas. Therefore, the AG concentration can be obtained by calculating the infrared. For the AG module that implements the measurements of multiple gases, multiple infrared filters are necessary.

Measurement principle of O₂

The oxygen (O₂) does not absorb the infrared within the above-mentioned wavebands, so the oxygen is measured based on its paramagnetism. Inside the sensor of the O₂ module, there are two crystal balls full of nitrogen. They are suspended in the symmetrical magnetic field, and they are designed to point to the strongest outgoing part of the magnetic field. Outside the balls is the paramagnetic oxygen. Therefore, the balls are forced, by the relatively stronger paramagnetic oxygen, out of the magnetic field. The moment of the force acting on the balls is proportional to the paramagnetic strength as well as to the concentration of the oxygen.

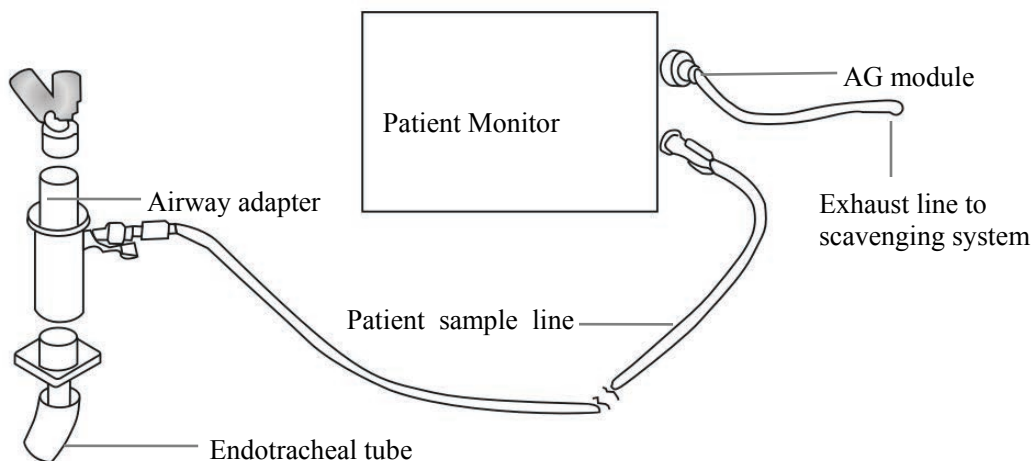


Figure 16-3 Connections for AG measurements

 **WARNING**

- **Ensure the compactness of the connection when performing gas measurements. Any leakage in the system will lead to incorrect readings because this leakage will make the surrounding environmental air mix up with the patient gas.**
 - **The water trap is used for collecting water condensates to protect the module from the ingress of water; when the collected water in the water trap reaches a specific volume, it must be removed, thus to avoid clogging in the gas system.**
 - **The water trap has filter materials inside, which protect the module from being contaminated by bacterium, liquid, or patient secretion. When the water trap works for a long time, dusts or other foreign bodies may block the filter materials, or even result in system clogging. In this case, replace the water trap. The recommended replacement period is 2 months.**
 - **Only gas sampling hoses recommended for the patient monitor are permitted. Otherwise, the performance and reliability of the AG module may be decreased.**
 - **In case a gas sampling hose is knotted, disuse it. Because the knot may cause clogging or leakage.**
 - **When an inspiratory anesthetic is used, use an exhaust hose to connect the outlet of the AG module to the exhaust disposal system of the hospital or to the anesthetic/respiration machine.**
 - **Use of high frequency electrosurgical equipment may increase the risk of burns. Do not use antistatic or conductive masks or breathing tubes.**
-

16.3 MAC

Minimum alveolar concentration (MAC) is the minimum concentration of the agent in the alveoli. It is a basic index to indicate the depth of anesthesia. The standard ISO 21647 defines MAC as this: alveolar concentration of an inhaled anesthetic agent that, in the absence of other anesthetic agents and at equilibrium, prevents 50% of patients from moving in response to a standard surgical stimulus.

Minimum alveolar concentration (MAC) values are listed below:

Agent	Des	Iso	Enf	Sev	Hal	N2O
1 MAC	7.3%	1.15%	1.7%	2.1%	0.77%	105%*

* indicates 1 MAC nitrous oxide can only be reached in hyperbaric chamber.

NOTE

-
- **The MAC values shown in the table above are those published by the U.S. Food and Drug Administration for a healthy 40-year-old adult male patient.**
 - **In actual applications, the MAC value may be affected by age, weight and other factors.**
-

The formula to calculate the MAC value is as follows:

$$MAC = \sum_{i=0}^{N-1} \frac{EtAgent_i}{AgentVol_i}$$

Where N is the number of all agents (including N₂O) that the AG module can measure, EtAgent_i is the concentration of each agent and AgentVol_i is the concentration of each agent at 1 MAC.

For example, the AG module measures there are 4% of Des, 0.5% of Hal and 50% of N₂O in the patient's end-tidal gas:

$$MAC = \frac{4.0\%}{7.3\%} + \frac{0.5\%}{0.77\%} + \frac{50\%}{105\%} = 1.67$$

NOTE

-
- **The formula mentioned above is intended for adult patients only.**
-

16.4 AG Setup Menu

Select the GAS label in the parameter window. The AG SETUP menu appears.

The screenshot displays the 'AG SETUP' menu with the following settings:

- AGENT: ---
- CO2 UNIT: mmHg
- O2 UNIT: ---
- N2O UNIT: %
- ENF UNIT: %
- PUMP RATE: LOW
- O2 COMPEN: OFF
- SWEEP: 6.25
- WORK MODE: STANDBY
- ALARM SETUP >>
- ADJUST WAVE AMP >>
- CONFIG >>

At the bottom of the menu, there is a 'Back to the upper menu.' button and an 'EXIT' button.

Figure 16-4 AG SETUP menu

In this menu, you can set the following items.

- Agent Used to select the name of the anesthetic to be monitored, including AA, HAL, ENF, ISO, SEV and DES.

If you select the AION 02 AG module, the patient monitor cannot identify the anesthetic type. Therefore, you have to select the used anesthetic before using the AG module so that the AG module can conduct measurements normally.

If you select the AION 03 AG module, the used anesthetic will be automatically displayed here, so you need not set this item.

- CO2 UNIT Options: mmHg, kPa and %.
- O2 UNIT Options: mmHg, kPa and %.
- N2O UNIT %
- AA UNIT %
- PUMP RATE Used to select the appropriate pump rate
3 options: HIGH, MED, LOW

HIGH: 200 ml/min for adult and pediatric, 120 ml/min for neonate.

MED: 150 ml/min for adult and pediatric, 100 ml/min for neonate.

LOW: 120 ml/min for adult and pediatric, 70 ml/min for neonate.

- O2 COMPEN The options include: OFF, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100%.

When the O2 concentration exceeds 60% and it is not being monitored, turn on this switch.

- SWEEP Used to select the speed to scan the screen waveforms.
Options: 6.25mm/s and 12.5mm/s.
- WORK MODE Options: MEASURE and STANDBY.

To monitor the anesthetic gas, select the MEASURE option. Otherwise, select the STANDBY option.

Alarm Setup Menu

Select ALARM SETUP >> in AG SETUP menu. The following menu appears.

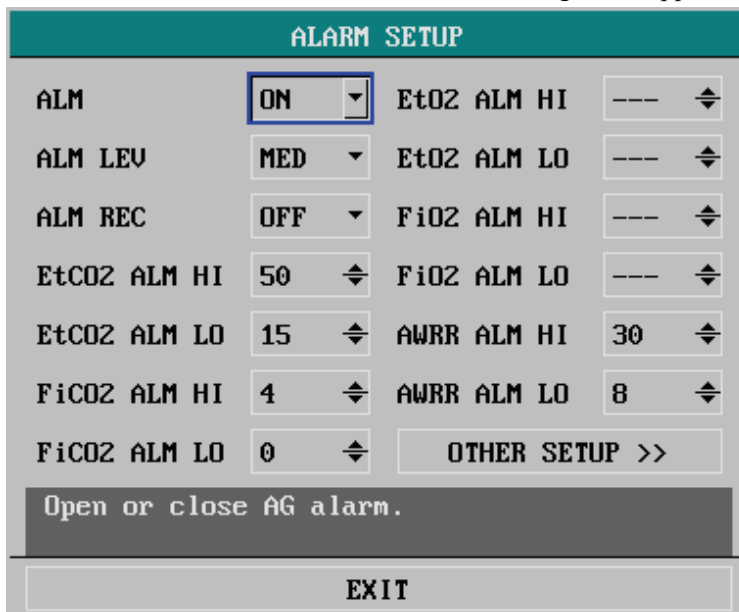



Figure 16-5 Alarm Setup Menu

In the ALARM SETUP menu-1, you can set the following items.

- ALM Alarm on/off status
ON: When the AG has an alarm, the system will give alarm indications and save the alarm information.
OFF: The system will not give alarm indications when an AG alarm occurs. Instead it will display  on the right of the GAS label in the parameter window.
- ALM LEV Options: HIGH and MED.
- ALM REC ON: The recorder outputs the alarm information in case an AG alarm occurs.
OFF: The recorder does not output the alarm information in case an AG alarm occurs.
- EtCO2 ALM HI Set the upper limit of EtCO2 which triggers the alarm

- EtCO2 ALM LO Set the lower limit of EtCO2 which triggers the alarm
- FiCO2 ALM HI Set the upper limit of FiCO2 which triggers the alarm
- FiCO2 ALM LO Set the lower limit of FiCO2 which triggers the alarm
- EtO2 ALM HI Set the upper limit of EtO2 which triggers the alarm
- EtO2 ALM LO Set the lower limit of EtO2 which triggers the alarm
- FiO2 ALM HI Set the upper limit of FiO2 which triggers the alarm
- FiO2 ALM LO Set the lower limit of FiO2 which triggers the alarm If FiO₂ is lower than 18%, a high level alarm will be triggered.

- AWRR ALM HI Set the upper limit of AwRR which triggers the alarm
- AWRR ALM LO Set the lower limit of AwRR which triggers the alarm

Select OTHER SETUP >> in ALARM SETUP menu. The following menu appears.

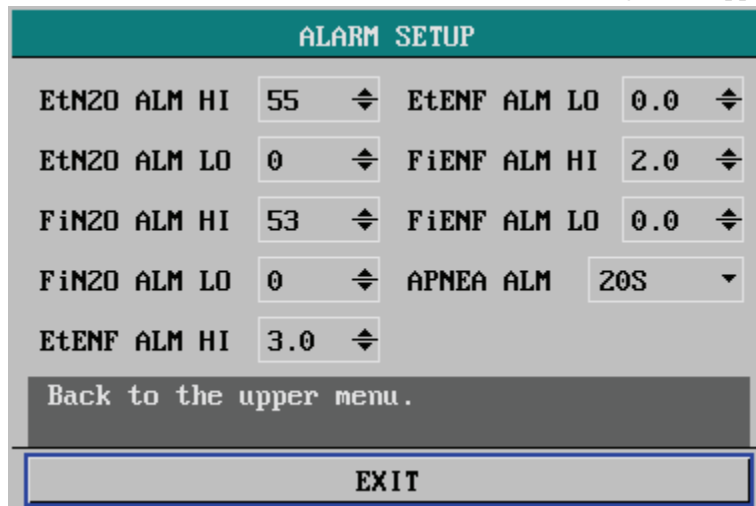


Figure 16-6 ALARM SETUP menu

In the ALARM SETUP menu-2, you can set the following items.

- EtN2O ALM HI Set the upper limit of EtN2O which triggers the alarm
- EtN2O ALM LO Set the lower limit of EtN2O which triggers the alarm
- FiN2O ALM HI Set the upper limit of FiN2O which triggers the alarm
- FiN2O ALM LO Set the lower limit of FiN2O which triggers the alarm
- EtAA ALM HI Set the upper limit of EtAA which triggers the alarm
- EtAA ALM LO Set the lower limit of EtAA which triggers the alarm
- FiAA ALM HI Set the upper limit of FiAA which triggers the alarm
- FiAA ALM LO Set the lower limit of FiAA which triggers the alarm
- APNEA ALM Used to set up the apnea alarm time.
Options: 20s, 25s, 30s, 35s and 40s.

Adjust Wave Amplitude Menu

Select ADJUST WAVE AMP>> in AG SETUP menu. The following menu appears.

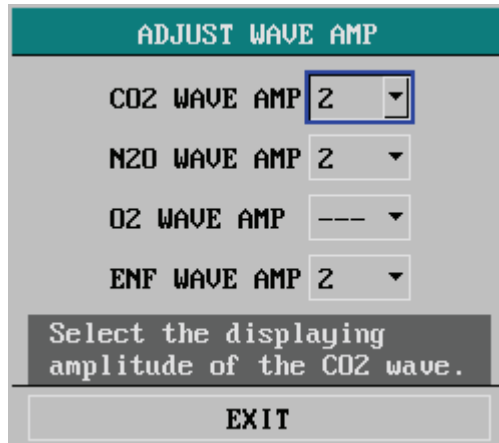


Figure 16-7 ADJUST WAVE AMP menu

In the ADJUST WAVE AMP menu, you can set the following items.

- CO2 WAVE AMP Used to adjust the display amplitude of CO2 waveform.
- N2O WAVE AMP Used to adjust the display amplitude of N2O waveform.
- O2 WAVE AMP Used to adjust the display amplitude of O2 waveform.
- AA WAVE AMP Used to adjust the display amplitude of AA waveform.

Where, 1 indicates the minimum amplitude, and 5 indicates the maximum.

Configuration Menu

Select CONFIG >> in AG SETUP menu. The AG CONFIG menu appears. In this menu, you can select FACTORY CONFIG or USER CONFIG.

16.5 Calibrating AG

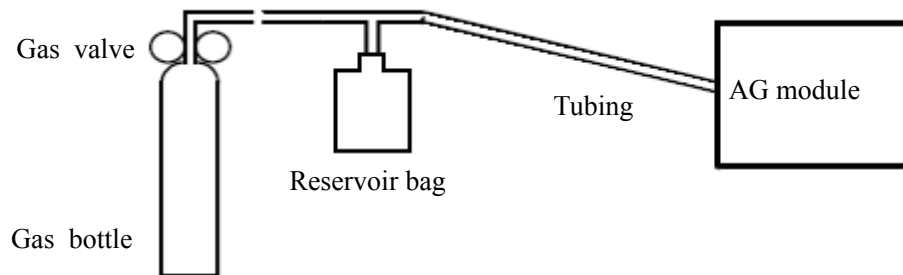
Calibrate the AG module every year or when the measured value has a great deviation.

Tools required:

- Gas bottle, with a certain standard gas or mixture gas. Gas concentration should meet the following requirements: AA>1.5%, CO₂>1.5%, N₂O>40%, O₂>40%, of which AA represents an anesthetic agent.
- T-shape connector
- Tubing
- Reservoir bag

Follow this procedure to perform a calibration:

1. Select MAINTAIN>> in SYSTEM MENU, enter USER KEY, then select CONFIRM button. Then selecting GAS CALIBRATE >> in USER MAINTAIN menu opens the GAS CALIBRATE menu.
2. Select VERIFY ACCURACY to check the airway and make sure that there are no occlusions or leaks.
 - ◆ Vent the tubing to the air and check if the CUR RATE and SET 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.
 - ◆ The CUR RATE shall fall rapidly and the system prompt that the tubing is blocked. Otherwise, it indicates that there are leakages in the tubing. Check the tubing for leakages.
3. Connect the gas bottle, reservoir bag and the tubing using a T-shape connector as shown in the figure below. Check the airway and make sure there are no leaks.
4. Open the gas valve and vent a certain standard gas or mixture gas into the tubing.



5. In the CALIBRATE menu, the concentration and flowrate of each measured gas are displayed
 - ◆ If the difference between the measured gas concentration and the actual one is very small, a calibration is not needed.
 - ◆ If the difference is great, you should perform a calibration. Select START CAL>> to enter the calibrate menu.
6. Enter the vented gas concentration. If you use only one gas for calibration, set other gases' concentration to 0.
7. Select CALIBRATE to start calibration.

-
8. If the calibration is finished successfully, the message CALIBRATION COMPLETED! is displayed. If the calibration failed, the message AG CAL. FAILED is displayed. Perform another calibration.
 9. Select EXIT to exit the current menu.

16.6 Maintenance and Cleaning

16.6.1 Occlusion handling

If the AG module passage is occluded, the screen will prompt “AG OCCLUSION”. Following are a few examples of occlusion, which you may remove one by one until this message disappears.

Entrance occlusion

If the part at the entrance such as the filter, sample line or airway adapter is occluded by the condensed water, the system will prompt on the screen that the airway is occluded.

The optimal method to remove clogs of this kind is:

- Check the filter for clogs. If it is clogged, replace the bacteria filter at the entrance.
- Check the sample pipe for clogs or knots. Replace it if necessary.
- Check the airway adapter for water. If necessary, drain the water and install the adapter again.

Internal Occlusion

If the interior of the AG module is contaminated by the condensed water, the system will prompt on the screen that the airway is occluded.

The optimal method to remove clogs of this kind is:

1. Check, as usual, the entrance or the exit for clogs, and remove them if any.
2. If the occlusion still exists after step 1, check for the existence of interior occlusion. In this case, contact our Customer Service.

16.6.2 Removing Exhaust Gases from the System

 **WARNING**

- **Anesthetics: When using the AG measurement on patients who are receiving or have recently received anesthetics, connect the outlet to a scavenging system, or to the anesthesia machine/ventilator, to avoid exposing medical staff to anesthetics.**
-

To remove the sample gas to a scavenging system, connect an exhaust tube to the gas outlet connector of the module.

FOR YOUR NOTES

17 Maintenance

WARNING

- **Failure on the part of the responsible hospital or institution employing the use of the monitoring equipment to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazard.**
 - **The safety inspection or maintenance, which requires opening the monitor housing, must be performed by trained and authorize personnel only. Otherwise, equipment failure and possible health hazard may be caused.**
-

17.1 Inspection and Maintenance

Make sure the qualified service personnel have implemented a complete inspection before putting the monitor into operation, after monitor servicing or system upgrading, or after the monitor has been used for 6-12 consecutive months. This is to ensure the normal operation of the system.

Follow these guidelines when inspecting the equipment:

- The environment and the power supply meet the specified requirements.
- Inspect the keys, control knob, connectors and accessories for damage.
- Inspect the power cords for fraying or other damage and check the insulation.
- The grounding cables are correctly connected.
- Only specified accessories like electrodes, sensors and probes are applied.
- The monitor clock is correct.
- The audible and visual alarms functions normally.
- The recorder functions normally and the recorder paper meets the requirement.
- Batteries are in good status and can operate normally.

The defibrillator synchronization function must be verified according to your hospital regulations, and be checked by a qualified technician once every 3 months.

In case of any damage or exception, do not use the monitor. Contact the technician in your hospital or our Customer Service immediately.

CAUTION

- **Be sure to check and maintain batteries regularly. For detailed battery check and maintenance procedures and battery guidelines, see *Section 2.5 Batteries*.**
-

17.2 Cleaning

WARNING

- **Be sure to shut down the system and disconnect all power cords from the outlet before cleaning the equipment.**
-

Your equipment should be cleaned on a regular basis. If there is heavy pollution or lots of dust and sand in your place, the equipment should be cleaned more frequently. Before cleaning the equipment, consult your hospital's regulations for cleaning, disinfecting and sterilizing equipment.

The exterior surfaces of the equipment may be cleaned with a clean and soft cloth, sponge or cotton ball, dampened with a non-erosive cleaning solution. Drying off excess cleaning solution before cleaning the equipment is recommended. Following are examples of cleaning solutions:

- Diluted soap water
- Diluted ammonia water
- Diluted sodium hypochlorite (bleaching agent)
- Diluted formaldehyde (35 to 37%)
- Hydrogen peroxide (3%)
- Ethanol (70%), or Isopropanol (70%)

To avoid damage to the equipment, follow these rules:

- ALWAYS dilute the solutions according to the manufacturer's suggestions.
- ALWAYS wipe off all the cleaning solution with a dry cloth after cleaning.
- NEVER submerge the equipment into water or any cleaning solution, or pour or spray water or any cleaning solution on the equipment.
- NEVER permit fluids run into the casing, switches, connectors, or any ventilation openings in the equipment.
- NEVER use abrasive, erosive cleaners, or cleaners containing acetone.

Failure to follow these rules may erode or fray the casing, or blur lettering on the labels, or cause equipment failures.

For cleaning information of accessories, please refer to the chapters for specific patient parameters and the instructions for use of the accessories.

17.3 Disinfection and Sterilization

Sterilization or disinfection may cause damage to the equipment. We recommend the sterilization and disinfection are contained in the hospital's servicing schedule only when necessary. The equipment should be cleaned prior to sterilization and disinfection.

Recommended sterilization material: Alcohol based (Ethanol 70%, Isopropanol 70%), and aldehyde based.

WARNING

- **Disinfection or sterilization may cause damage to the equipment; therefore, when preparing to disinfect or sterilize the equipment, consult your hospital's infection controllers or professionals.**
 - **The cleaning solutions above can only be used for general cleaning. If you use them to control infections, we shall assume no responsible for the effectiveness.**
-

NOTE

- **ALWAYS dilute the solutions according to the manufacturer's suggestions and adopt lower concentration if possible.**
 - **NEVER submerge the equipment into water or any solution, or pour water or any solution on the equipment;**
 - **ALWAYS wipe off all the excess liquids on the equipment surface and accessory surface with a dry cloth;**
 - **Never use EtO and formaldehyde to disinfect.**
 - **Never permit high-pressure and high-temperature disinfection of the equipment and accessories.**
-

FOR YOUR NOTES

18 Accessories



WARNING

- **Use accessories specified in this chapter. Using other accessories may cause damage to the patient monitor or not meet the claimed specifications.**
 - **The operating and storage conditions of the patient monitor should meet the specifications claimed by respective accessories. For environmental specifications of each accessory, refer to instructions for use of respective accessories.**
 - **Single-use accessories are not designed to be reused. Reuse may cause a risk of contamination and affect the measurement accuracy.**
 - **Check the accessories and their packages for any sign of damage. Do not use them if any damage is detected.**
-

18.1 ECG Accessories

ECG Electrodes

Model	Quantity	Patient Category	Part No.
210	10 pieces	Adult	0010-10-12304

Separate Trunk Cable

Leadwire supported	Compatible with	Model	Type	Patient Category	Part No.
3-leadwire	AHA	EV 6122	Defibrillator -proof	Neonate, Infant	040-000753-00
3-leadwire		EV 6102		Neonate	0010-30-12377
3/5-leadwire		EV 6101		Adult, pediatric	0010-30-42782

Note: The cables listed in the table above must be used together with leadwires.

Cable Sets

3-Electrode Cable Sets					
Type	Compatible with	Model	Patient Category	Part No.	Remark
Clip	AHA	EL6301A	Adult, pediatric	0010-30-42726	/
		EL6303A		0010-30-42731	Long
		EL6305A	Neonate	0010-30-42896	/
		EL6311A	Neonate, Infant	040-000148-00	DIN Connector
Snap	AHA	EL6301B	Adult, pediatric	0010-30-42734	/
		EL6311B	Neonate, Infant	040-000146-00	DIN Connector

5-Electrode Cable Sets					
Type	Compatible with	Model	Patient Category	Part No.	Remark
Clip	AHA	EL6501A	Adult, pediatric	0010-30-42727	/
		EL6503A		0010-30-42729	Long
Snap	AHA	EL6501B		0010-30-42735	/

Note: The leadwires listed in the table above must be used with separate trunk cables. And the leadsets with DIN connector should be used only with the cable EV6122.

18.2 SpO₂ Accessories

Extension Cable

Module type	Part No.
Mindray DS SpO ₂ Module	0010-20-42594

SpO₂ Sensors

The SpO₂ sensor material that patients or other staff will come into contact with have undertaken the bio-compatibility test and is verified to be in compliance with ISO 10993-1.

Mindray SpO ₂ Module			
Type	Model	Patient Category	Part No.
Single patient use	520A	Adult (>30Kg)	520A-30-64101
	520P	Pediatric (10 to 50Kg)	520P-30-64201
	520I	Infant (3 to 20Kg)	520I-30-64301
	520N	Neonate(<3Kg)	520N-30-64401
Reusable	518B	Adult, pediatric, neonate (multi-sites)	518B-30-72107
	512F	Adult (Finger type)	512F-30-28263
	512H	Pediatric (Finger type)	512H-30-79061

- The main cable must be used with the matching SpO₂ sensor.
- Wavelength emitted by the sensors intended for Mindray SpO₂ module: red light: 660 nm, infrared light: 905 nm.
- Wavelength emitted by the sensors intended for Nellcor SpO₂ module: red light: 660 nm, infrared light: 890 nm.
- The maximum photic output consumption of the sensor is less than 18 mW.

The information about the wavelength range and maximum photic output consumption can be especially useful to clinicians, for example, clinicians performing photodynamic therapy.

18.3 NIBP Accessories

Tubing

Type	Patient Category	Part No.
Reusable	Adult, pediatric	509B-30-06259
	Neonate	509B-30-06260

Reusable Cuff

Model	Patient Category	Measurement Site	Limb Circumference (cm)	Part No.
/	Blood Pressure Cuff Starter Kit	/	/	0020-00-0184-01

Single-Patient Cuff

Model	Patient Category	Measurement Site	Limb Circumference (cm)	Part No.
CM1500A	Neonate	Arm	3.1 to 5.7	001B-30-70692
CM1500B			4.3 to 8.0	001B-30-70693
CM1500C			5.8 to 10.9	001B-30-70694
CM1500D			7.1 to 13.1	001B-30-70695

18.4 TEMP Accessories

Extension Cable

Type	Model	Temp probe	Part No.
Reusable	MR420	MR411, MR412	0011-30-90444

Temp Probes

Type	Model	Patient Category	Measurement Site	Part No.
Reusable	MR401	Adult	Esophageal/Rectal	0011-30-90440
	MR403		Skin	0011-30-90442
	MR402	Pediatric, neonate	Esophageal/Rectal	0011-30-90441
	MR404		Skin	0011-30-90443
Disposable	MR411	/	Esophageal/Rectal	0011-30-90446
	MR412		Skin	0011-30-90447

Note: The disposable Temp probes listed in the table above must be used with the matching extension cables.

18.5 IBP Accessories

Accessories Kit No.	Model	Components	Part No.
/	IM 2101	IM2201 6Pin IBP Cable (for Hospira)	001C-30-70760
/	IM 2102	IM2102 6Pin IBP Cable (for BD)	001C-30-70758
/	/	6 Pin IBP Cable for Memscap (SP844 transducer)	0010-21-43081
/	/	6 Pin IBP Cable for Edwards	0010-21-43094

It is proved through tests that the following accessories are compatible with the patient monitor. Only the accessories preceded by “*” are available from our company. If you want to purchase other accessories, contact respective manufacturers and make sure if these accessories are approved for sale in local.

Manufacturer	Accessory
Smith Medical (Medex)	MX961Z14 trunk cable MX960 transducer MX9605A monitoring kit MX960E6441 transducer seat MX261 single channel transducer holder MX262 dual-channel transducerr holder (More transducer holders are available. refer to Medex for detail)
Braun	Trunk cable (REF: 5203511) Combitrans series minitoring kit (Refer to Braun for detail) Transducer holder (REF: 5215800) Transducer seat (Refer to Braun for detail)
Memscap	*Trunk cable (0010-21-43081) SP844 transducer 844-26 monitoring kit 84X-49 transducer rest
Utah	Trunk cable (REF: 650-201) Deltran series transducers (Multiple types of Deltran series transducers are available, refer to Utah for detail) transducer holder (ERF: 650-150) 3-hole Deltran rest (REF: 650-100) 4-hole Deltran rest (REF: 650-105)
Edwards	*Trunk cable (0010-21-43094) Truwave series transducers (Multiple types of Truwave series transducers are available, refer to Edwards for detail) DTSC transducer holder DTH4 transducer rest

18.6 CO₂ Accessories

18.6.1 Mindray DS CO₂ Accessories

Material	Patient Category	Remark	Part No.
DRYLINE Watertrap	Adult, pediatric	Reusable	9200-10-10530
DRYLINE Watertrap	Neonate		9200-10-10574
Sampling Line, Adult 2.5m	Adult, pediatric	Disposable	9200-10-10533
Sampling Line, Neonate, 2.5m	Neonate		9200-10-10555
Adult Nasal CO ₂ Sample Cannula	Adult		M02A-10-25937
Pediatric Nasal CO ₂ Sample Cannula	Pediatric		M02A-10-25938
Infant Nasal CO ₂ Sample Cannula	Infant		M02B-10-64509
DRYLINE Airway Adapter	/	Straight	9000-10-07486

18.6.2 Oridion CO₂ Accessories

Model	Patient Category	Remark	Part No.
Starter kit	/	/	9201-30-36019

18.7 AG Accessories

Material	Patient Category	Remark	Part No.
Watertrap	Adult, pediatric	Reusable	9200-10-10530
	Neonate		9200-10-10574
Sampling line	Adult, pediatric	Disposable	9200-10-10533
	Neonate		9200-10-10555
Airway adapter	Adult, pediatric, neonate	Disposable, straight	9000-10-07486
	Adult, pediatric, neonate	Disposable, elbow	9000-10-07487

18.8 Others

Model	Part No.
Lithium battery	M05-010001-06 (black)
	0146-00-0099 (gray)
CF storage card	023-000034-00
	0000-10-10798
Data output software package	7000-30-24590
U.S. power cord	DA8K-10-14452
Grounding cable	1000-21-00122
Nurse call cable	8000-21-10361
Roll Stand bracket	0010-30-42942
Wall Mount bracket	0010-30-42951
Bedrail Hook	8000-30-90169
Bedrail Clamp	8000-30-90170
9201 Transition plate kit	115-003477-00

-

A Product Specifications

A.1 Safety Classifications

Type of protection against electric shock	Class I with internal electric power supply. Where the integrity of the external protective earth (ground) in the installation or its conductors is in doubt, the equipment shall be operated from its internal electric power supply (batteries)
Degree of protection against electric shock	CO2/AG: BF (defibrillation proof) ECG/RESP/TEMP/SpO2/NIBP/IBP: CF (defibrillation proof)
Degree of protection against hazards of ignition of flammable anesthetic mixtures	Not protected (ordinary)
Degree of protection against harmful ingress of water	Not protected (ordinary)
Mode of operation	Continuous
Equipment type	Portable

A.2 Environmental Specifications

Operating temperature	0 to 40°C
	5 to 35°C (With CO2 module)
	10 to 35°C (With AION AG module)
Operating humidity	15 to 95%, noncondensing
Operating altitude	-500 to 4600 m (-1640 to 15092 feet)
	-305 to 3014 m (-1000 to 9889 feet) (with CO2, AG or Nellcor SpO2 module)
Storage temperature	-20 to 60°C
Storage humidity	10 to 95%, noncondensing
Storage and transportation altitude	-500 to 13100 m (-1640 to 42979 feet)
	-305 to 6096 m (-1000 to 20000 feet) (with CO2, AG or Nellcor SpO2 module)

A.3 Power Source Specifications

AC Power Supply Specifications	
Input voltage	100 to 240 V~
Current	1.4A to 0.6A
Frequency	50/60 Hz
Fuse	T 3 A, 250 V
Internal battery	
Number of batteries	2
Type	Sealed lead-acid battery or lithium-ion battery
Time to shutdown	>5 min (after the first low-power alarm)
Sealed lead-acid battery	
Nominal voltage	12 VDC
Capacity	2.3 Ah
Operating time	48 minutes or 120 minutes typical when powered by one or two new fully-charged batteries respectively (25°C, ECG, SpO ₂ , NIBP measurement per 15 minutes).
Charge time	A maximum of 6 h for each battery, and a maximum of 12h for both (in the running status or standby mode)
Lithium battery	
Rated voltage	11.1 VDC
Capacity	4.4 Ah
Operating time	120 minutes or 300 minutes typical when powered by one or two new fully-charged batteries respectively (25°C, ECG, SpO ₂ , NIBP measurement per 15 minutes).
Charge time	A maximum of 6.5h (in the running status or standby mode)

A.4 Hardware Specifications

Physical	
Size	318 × 270 × 137mm (width×height×depth)
Weight	Different due to different configurations Standard configuration: 4.7kg Maximum weight: ≤ 7.5kg
Display	
Type	Color TFT LCD
Size	12.1 inches (diagonal)
Resolution	800×600 pixels
Recorder	
Type	Thermal dot array
Horizontal resolution	160 dots/cm (at 25 mm/s recording rate)
Vertical resolution	80 dots/cm
Width of the recorder paper	50 mm
Length of the recorder paper	20 m
Recording rate	25 mm/s, 50 mm/s
Recorded waveforms	3
LED indicator	
Alarm indicator	1 (yellow and red)
Running status indicator	1 (green)
AC power indicator	1 (green)
Battery indicator	1 (green)
Audio indicator	
Speaker	Giving audio alarms (45 to 85 dB), keypad tones, and heartbeat/pulse tone. Supporting PITCH TONE and multi-level volume. Audio alarms comply with EN 60601-1-8 and IEC60601-1-8.
Connectors	
Power supply	1 AC power connector
Network	1 standard RJ45 network connector, 100 BASE-TX
VGA	1 standard color VGA monitor connector, 15-PIN D-sub
Auxiliary output	1 BNC connector
Equipotentiality	1 equipotential grounding connector

A.5 Data Storage

Trend data	Long trend: 96 hours, resolution 1min, 5 min or 10 min. Short trend: 1 hour, resolution 1 s or 5 s.
Alarm events	70 alarm events and associated waveforms (with user selectable waveform length 8s, 16 or 32).
NIBP measurements	800 NIBP groups, including systolic pressures, mean pressures, diastolic pressures and measurement time.

A.6 Wireless Network

Standards	IEEE 802.11g, Wi-Fi compatible						
Frequenc range	2.412 to 2.462GHz						
Operating channel	China	America	Canada	Europe	Spain	France	Japan
	1 to 11				10, 11		2
	For other country, please refer to your local law.						
Safe distance	10 m (a circle centering AP with the diameter of 10 m)						

A.7 Signal Output Specifications

Standards	Meets the requirements of EC60601-1 for short-circuit protection and leakage current
Output impedance	50Ω
ECG analog output	
Bandwidth (-3dB; reference frequency: 10Hz)	Diagnostic mode: 0.05 to 100 Hz (812A module) 0.05 to 150 Hz (M08A module) Monitor mode: 0.5 to 40 Hz Surgery mode: 1 to 20 Hz
Maximum propagation delay	25 ms (In DIAGNOSTIC mode, NOTCH is OFF)
Sensitivity	1 V/mV± 5%
PACE rejection/enhancement	No pace rejection or enhancement
IBP analog output	
Bandwidth	0 to 12.5 Hz (-3 dB, reference frequency: 1 Hz)
Maximum propagation Delay	55 ms (the filter function is disabled)
Sensitivity	1 V/100 mmHg ±5%
Nurse call output	
Driver	Relay
Electrical specifications	≤60W, ≤2A, ≤36VDC, ≤25VAC

Conducting resistance	< 1Ω
Isolation voltage	> 1500 VAC
Signal type	Normally open or normally closed, selectable
Defibrillator synchronization pulse	
Maximum time delay	35 ms (R-wave peak to leading edge of the pulse)
Amplitude	3.5 V (min) at 3 mA sourcing; 0.8 V (max) at 1 mA sinking
Pulse width	100 ms ±10%
Rising and falling time	< 3 ms
VGA	
Connector type	15-PIN D-sub socket
Signal	RGB: 0.7 Vp-p/75Ω; Horizontal/vertical synchronization: TTL level

A.8 ECG Specifications

A.8.1 Mindray DS Software Package

Lead naming style	AHA, EURO
Lead fault	The lead resistance is no greater than 51 kΩ and it is in parallel with a 0.047 μF capacitor, it will not cause a lead fault condition. For 3/5-lead, differential offsets ≤ ±300 mV, it will not cause a lead fault condition.
Sensitivity selection	1.25 mm/mV (×0.125), 2.5 mm/mV (×0.25), 5 mm/mV (×0.5), 10 mm/mV (×1), 20 mm/mV (×2) and AUTO
Sweep speed	12.5 mm/s, 25 mm/s, 50 mm/s
Bandwidth (-3 dB)	Diagnostic mode: 0.05 to 100 Hz (812A module) 0.05 to 150 Hz (M08A module) Monitor mode: 0.5 to 40 Hz Surgery mode: 1 to 20 Hz
Common mode rejection	Diagnostic mode: ≥90 dB Monitor mode: ≥105 dB Surgery mode: ≥105 dB (The notch filter is turned off.)
50/60Hz Notch Filtering	The monitor provides software filtering against the 50/60HZ industrial frequency. In monitor and surgery modes, the 50/60HZ filter will be turned on automatically. In diagnostic mode, the 50/60HZ filter will be turned off.
Input offset current	≤0.1μA (except currents to drive leads)
Differential input impedance	≥ 5MΩ

Input signal range	±8mV (peak-to-peak value)
Accuracy of input signal reproduction	Methods A and D were used to establish overall system error and frequency response according to EC11.
Auxiliary current (Leads off detection)	Active electrode: < 0.1 µA Reference electrode: < 1 µA
Patient leakage current	< 10µA
Recovery time after defibrillation	< 5s
Calibration signal	1 mV (peak-to-peak value), precision: ±5%
ESU protection	Incision mode: 300W Congelation mode: 100W Restore time: ≤10s The monitor complies with the requirements of ANSI/AAMI EC13 Section 4.2.9.14.
ESU noise control	The monitor uses the ECG leads meeting the requirements of AAMI; based on the ECG baseline, the peak noise ≤ 2mV The monitor complies with the test method in EC13 Section 5.2.9.14.
HR	
Measurement range	Neonate: 15 to 350 bpm Pediatric: 15 to 350 bpm Adult: 15 to 300 bpm
Resolution	1 bpm
Precision	±1 bpm or ±1%, whichever is greater.
Trigger threshold level	200 µV (lead II)
Trigger indication	There will be an audible beep on every beat captured.
Heart Rate Averaging	The average Heart Rate is computed in line with the ANSI/AAMI EC13 Section 4.1.2.1 d) as follows: When the last 3 R-to-R intervals > 1200 ms, compute the average of the last 4 R-to-R intervals; otherwise, compute the average of the last 12 R-to-R intervals minus the longest and shortest intervals. The displayed Heart Rate is updated once per second.
Heart Rate Meter Accuracy and Response to Irregular Rhythm	When tested in accordance with the ANSI/AAMI EC13 Section 4.1.2.1 e), the indicated heart rate after a 20 second stabilization period is: Figure 3a (Ventricular Bigeminy) -80±1 bpm Figure 3b (Slow Alternating Ventricular Bigeminy) -60±1 bpm Figure 3c (Rapid Alternating Ventricular Bigeminy) -120±1bpm Figure 3d (Bi-directional Systoles) -90±2 bpm
Response time to heart rate changes	Meets the requirement of ANSI/AAMI EC13: Section 4.1.2.1 f). Less than 11 sec for a step increase from 80 to 120 BPM Less than 11 sec for a step decrease from 80 to 40 BPM

Response time of tachycardia alarm	When tested in accordance with ANSI/AAMI EC13 Section 4.1.2.1 g, the response time is as follows: Figure 4ah – range: 15.7 to 19.2s, average: 17.4s 4a – range: 5.7 to 8.5s, average: 7.5s 4ad – range: 3.6 to 5.1s, average: 4.2s Figure 4bh – range: 11.5 to 14.7s, average: 12.9s 4b – range: 4 to 14s, average: 7.2s 4bd – range: 6.6 to 14.5s, average: 10.5s
Tall T-Wave Rejection	When tested in accordance with the ANSI/AAMI EC13 Section 4.1.2.1 c), the heart rate meter will reject all T-waves with amplitudes less than 1.2 mV, 100 ms QRS, a T wave duration of 180ms and a Q-T interval of 350 ms.
Pace pulse	
Pulse indicator	Pace pulses meeting the following conditions are marked by the PACE indicator.
	Amplitude: ± 4 to ± 700 mV (3/5-lead)
	Width: 0.1 to 2 ms
	Rise time: 10 to 100 μ s
Pulse rejection	When tested in accordance with the ANSI/AAMI EC13: Sections 4.1.4.1 and 4.1.4.3, the heart rate meter rejects all pulses meeting the following conditions. Amplitude: ± 2 to ± 700 mV Width: 0.1 to 2 ms Rise time: 10 to 100 μ s Min. input slew rate: 20V/s RTI

A.8.2 Mortara Software Package

Lead naming style	AHA, EURO
Lead fault	The lead resistance is no greater than 51 k Ω and it is in parallel with a 0.047 μ F capacitor, it will not cause a lead fault condition. For 3/5-lead, differential offsets $\leq \pm 300$ mV, it will not cause a lead fault condition. For 12-lead, differential offsets $\leq \pm 500$ mV, it will not cause a lead fault condition.
Sensitivity selection	1.25 mm/mV ($\times 0.125$), 2.5 mm/mV ($\times 0.25$), 5 mm/mV ($\times 0.5$), 10 mm/mV ($\times 1$), 20 mm/mV ($\times 2$) and AUTO
Sweep speed	12.5 mm/s, 25 mm/s, 50 mm/s
Bandwidth (-3 dB)	Diagnostic mode: 0.05 to 150 Hz (M08A module) Monitor mode: 0.5 to 40 Hz Surgery mode: 1 to 20 Hz
Common mode rejection	Diagnostic mode: ≥ 90 dB Monitor mode: ≥ 105 dB Surgery mode: ≥ 105 dB (The notch filter is turned off.)
50/60Hz Notch Filtering	The monitor provides software filtering against the 50/60HZ industrial frequency. In monitor and surgery modes, the 50/60HZ filter will be turned on automatically. In diagnostic mode, the 50/60HZ filter will be turned off.
Input offset current	$\leq 0.1 \mu$ A (except currents to drive leads)
Differential input impedance	$\geq 5M\Omega$
Input signal range	± 8 mV (peak-to-peak value)
Accuracy of input signal reproduction	Methods A and D were used to establish overall system error and frequency response according to EC11.
Auxiliary current (Leads off detection)	Active electrode: $< 0.1 \mu$ A Reference electrode: $< 1 \mu$ A
Patient leakage current	$< 10\mu$ A
Recovery time after defibrillation	< 5 s
Calibration signal	1 mV (peak-to-peak value), precision: $\pm 5\%$
ESU protection	Incision mode: 300W Congelation mode: 100W Restore time: ≤ 10 s The monitor complies with the requirements of ANSI/AAMI EC13 Section 4.2.9.14.
ESU noise control	The monitor uses the ECG leads meeting the requirements of AAMI; based on the ECG baseline, the peak noise ≤ 2 mV

	The monitor complies with the test method in EC13 Section 5.2.9.14.
HR	
Measurement range	Neonate: 15 to 350 bpm Pediatric: 15 to 350 bpm Adult: 15 to 300 bpm
Resolution	1 bpm
Precision	±1 bpm or ±1%, whichever is greater.
Trigger threshold level	200 µV (lead II)
Trigger indication	There will be an audible beep on every beat captured.
Heart Rate Averaging	The average Heart Rate is computed in line with the ANSI/AAMI EC13 Section 4.1.2.1 d) as follows: The average heart rate is calculated on the basis of the mean RR-interval of the last 16 beats, unless the heart rate calculated using the last 4 beats is less than or equal to 48, then this rate is used. The displayed Heart Rate is updated once per second.
Heart Rate Meter Accuracy and Response to Irregular Rhythm	When tested in accordance with the ANSI/AAMI EC13 Section 4.1.2.1 e), the indicated heart rate after a 20 second stabilization period is: Figure 3a (Ventricular Bigeminy) -80±1 bpm Figure 3b (Slow Alternating Ventricular Bigeminy) -60±1 bpm Figure 3c (Rapid Alternating Ventricular Bigeminy) -120±1 bpm Figure 3d (Bi-directional Systoles) -90±2 bpm
Response time to heart rate changes	Meets the requirement of ANSI/AAMI EC13: Section 4.1.2.1 f). Less than 11 sec for a step increase from 80 to 120 BPM Less than 11 sec for a step decrease from 80 to 40 BPM
Response time of tachycardia alarm	When tested in accordance with ANSI/AAMI EC13 Section 4.1.2.1 g), the response time is as follows. Figure 4ah – range: 4.30 to 5.34s, average: 4.75s 4a – range: 3.94 to 5.92s, average: 4.69s 4ad – range: 4.28 to 5.18s, average: 4.78s Figure 4bh – range: 3.57 to 8.22s, average: 4.83s 4b – range: 3.09 to 4.11s, average: 3.64s 4bd – range: 3.20 to 4.52s, average: 4.09s
Tall T-Wave Rejection	When tested in accordance with the ANSI/AAMI EC13 Section 4.1.2.1 c), the heart rate meter will reject all T-waves with amplitudes less than 1.2 mV, 100 ms QRS, a T wave duration of 180ms and a Q-T interval of 350 ms.
Pace pulse	
Pulse indicator	Pace pulses meeting the following conditions are marked by the PACE indicator.

	Amplitude: ± 4 to ± 700 mV (3/5-lead) ± 2 to ± 700 mV (12-lead) Width: 0.1 to 2 ms Rise time: 10 to 100 μ s
Pulse rejection	When tested in accordance with the ANSI/AAMI EC13: Sections 4.1.4.1 and 4.1.4.3, the heart rate meter rejects all pulses meeting the following conditions. Amplitude: ± 2 to ± 700 mV Width: 0.1 to 2 ms Rise time: 10 to 100 μ s Min. input slew rate: 20 V/s RTI
ST segment measurement	
Measurement range	-2.0 to +2.0 mV
Precision	-0.8 to +0.8 mV: ± 0.02 mV or $\pm 10\%$, whichever is greater Beyond this range: Undefined
Update period	Updated every 16 valid beats

A.9 RESP Specifications

Measurement technique	Thoracic impedance
Lead	Optional: lead I and lead II; default lead II
Respiration excitation waveform	< 300 μ A, sinusoid, 62.8 kHz ($\pm 10\%$)
Respiration impedance test range	0.3 to 3 Ω
Baseline impedance range	200 to 2500 Ω (using an ECG cable with 1k Ω resistance)
Differential input impedance	> 2.5 M Ω
Linear Signal Range	3 Ω p-p minimum
Bandwidth	0.2 to 2 Hz (-3 dB)
Sweep speed	6.25 mm/s, 12.5 mm/s, 25 mm/s
RR	
Measurement range	Adult: 0 to 120 BrPM Pediatric/neonate: 0 to 150 BrPM
Resolution	1 BrPM
Precision	7 to 150 BrPM: ± 2 BrPM or $\pm 2\%$, whichever is greater. 0 to 6 BrPM: Undefined.
Apnea alarm delay	10 to 40 s

A.10 SpO₂ Specifications

A.10.1 Mindray DS SpO₂ Module

All SpO₂ sensors specified in the section *Mindray DS SpO₂ Accessories* meets the following specifications when used with Mindray DS SpO₂ module.

SpO₂	
Measurement range	0 to 100%
Resolution	1%
Precision	70 to 100%: ±2 % (adult/pediatric, non-motion conditions) 70 to 100%: ±3% (neonate, non-motion conditions)* 0% to 69%: Undefined.
Refreshing rate	1 s
Averaging time	7 s (When the sensitivity is set to High) 9 s (When the sensitivity is set to Medium) 11 s (When the sensitivity is set to Low)
PR	
Measurement range	20 to 254 bpm
Resolution	1 bpm
Precision	±3 bpm (non-motion conditions)
Refreshing rate	1 s

* A study was performed to validate the accuracy of this monitor with 520N SpO₂ sensor. Totally 122 neonates (65 male & 57 female) aged from 1 day to 30 days with a gestation age of 22 weeks to full term were involved in this study. The statistical analysis of the 200 pairs of data over the range of 72% to 100% SaO₂ of this study shows that the accuracy (Arms) is 2.47 digits, which is within the stated accuracy specification. Another study performed on adult subjects also shows the effectiveness.

This monitor with 520N SpO₂ sensor was validated on adult subjects (1.62% Arms) and that actual performance in the neonatal population was observed.

A.10.2 Nellcor SpO₂ Module

All SpO₂ sensors specified in the section *Nellcor SpO₂ Accessories* meets the following specifications when used with Nellcor SpO₂ module.

	Sensor	Range	Precision*
SpO ₂ measurement range and precision	MAX-A, MAX-AL, MAX-N, MAX-P, MAX-I and MAX-FAST	70 to 100% 0% to 69%	±2% Undefined
	OxiCliq A, OxiCliq N, OxiCliq P, OxiCliq I	70 to 100% 0% to 69%	±2.5% Undefined
	D-YS, DS-100A, OXI-A/N and OXI-P/I	70 to 100% 0% to 69%	±3% Undefined
	MAX-R, D-YSE and D-YSPD	70 to 100% 0% to 69%	±3.5% Undefined
	PR measurement range and precision	20 to 250 bpm: ±3 bpm 251 to 300 bpm: Undefined	
Refreshing rate	1 s		
Averaging time	8 s, 16 s		
*: When sensors are used on neonatal subjects as recommended, the specified precision range is increased by ±1%, to account for the theoretical effect on oximeter measurements of fetal hemoglobin in neonatal blood.			

A.11 NIBP Specifications

Measurement technique	Auto oscillation			
Displayed parameters	Systolic pressure, diastolic pressure, mean pressure and PR			
Mode of operation	Manual, auto and continuous			
Measurement interval in auto mode	1/2/3/4/5/10/15/30/60/90/120/180/240/480 minutes			
Measurement time in continuous mode	5 minutes			
Measurement range in normal mode	mmHg	Adult	Pediatric	Neonate
	Systolic pressure	40 to 270	40 to 200	40 to 135
	Diastolic pressure	10 to 210	10 to 150	10 to 100
	Mean pressure	20 to 230	20 to 165	20 to 110
Measurement precision	Maximum average error: ± 5 mmHg Maximum standard deviation: 8mmHg			
Resolution	1mmHg			
Static pressure measurement range	0 to 300mmHg			
Static accuracy	± 3 mmHg			
Over-pressure protection by software	Adult:	297 \pm 3 mmHg		
	Pediatric:	240 \pm 3 mmHg		
	Neonate:	147 \pm 3 mmHg		
Over-pressure protection by hardware	Adult:	330 mmHg		
	Pediatric:	330 mmHg		
	Neonate:	165 mmHg		
Default start pressure	Adult:	178 \pm 5 mmHg		
	Pediatric:	133 \pm 10 mmHg		
	Neonate:	67 \pm 5 mmHg		
PR from NIBP				
Measurement range	40 to 240 bpm			
Precision	± 3 bpm or $\pm 3\%$, whichever is greater			
Resolution	1 bpm			

A.12 TEMP Specifications

Number of channels	2
Displayed parameters	T1, T2 and TD
Measurement range	0 to 50°C (32 to 122°F)
Resolution	0.1°C
Precision	±0.1°C (excluding the sensor) ±0.2°C (including the YSI 400 series sensor)
Update period	1s
Minimum time for accurate measurement	Body surface: < 100s Body cavity: < 80s (YSI 400 series sensor)

A.13 IBP Specifications

Number of channels	2	
Pressure readings	Systolic, diastolic, mean pressures and PR	
Pressure labels	ART, PA, CVP, RAP, LAP, ICP, P1 and P2	
Linear input range	will be -50 to + 300 mmHg, after zeroing.	
Measurement range	ART	0 to 300 mmHg
	PA	-6 to 120 mmHg
	CVP/RAP/LAP/ICP	-10 to 40 mmHg
	P1/P2	-50 to 300 mmHg
Resolution	1 mmHg	
Precision	±2% or ±1 mmHg, whichever is greater	
Excitation	will be 5 Volts DC, ± 2% Minimum load resistance will be 300Ω per transducer.	
Update period	1s	
Zero offset range	± 200 mmHg	
Zero accuracy	± 1 mmHg	
Noise	<0.5 mmHg RTI, DC to 12.5 Hz, 300Ω source impedance.	
Drift	<0.15 mmHg/°C; will not exceed ± 1 mmHg in 24 hours.	
Frequency Response	DC-12.5Hz ±1 Hz, -3db	
PR from IBP		
Measurement range	25 to 350 bpm	
Precision	±1 or ±1%, whichever is greater.	

Resolution	1 bpm
Pressure transducer	
Excitement voltage	5 VDC, $\pm 2\%$
Sensitivity	5 $\mu\text{V}/\text{V}/\text{mmHg}$
Impedance range	300 to 3000 Ω
Volume displacement (ABBOTT)	$<0.04 \text{ mm}^3 / 100 \text{ mmHg}$

A.14 CO₂ Specifications

Measurement technique	Infrared absorption technique
Displayed parameter	EtCO ₂ , FiCO ₂ , Respiration Rate
CO ₂ function	Meet the requirements of EN ISO21647/ISO 21647 and ISO9918.

A.14.1 Mindray DS CO₂ Specifications

CO ₂ measurement range	0 to 99mmHg
Precision*	0 to 40 mmHg: $\pm 2 \text{ mmHg}$ 41 to 76 mmHg: $\pm 5\%$ 77 to 99 mmHg: $\pm 10\%$
Resolution	1 mmHg
Drift	meet the requirement of accuracy in 6 hours
Sample flow rate	70, 100 ml/min
Precision of deflation rate	$\pm 15\%$ or 15 ml/min, whichever is great
Start-up time of CO ₂ module	$< 1\text{min}$, the module enters the warming up status after the startup. One minute later, it enters the ready-to-measure status.
AwRR measurement range	0 to 120 BrPM
Precision	0 to 70 BrPM: $\pm 2 \text{ BrPM}$ > 70 BrPM: $\pm 5 \text{ BrPM}$
Response time	When measured with a neonatal watertrap and a 2.5 m-long neonatal sampling line: $< 3.5 \text{ s @ } 100 \text{ ml/min}$ $< 4 \text{ s @ } 70 \text{ ml/min}$ When measured with an adult watertrap and a 2.5 m-long adult sampling line: $< 5.5 \text{ s @ } 100 \text{ ml/min}$ $< 7 \text{ s @ } 70 \text{ ml/min}$
Delay time	When measured with a neonatal watertrap and a 2.5m-long neonatal sampling line:

	<3 s @ 100 ml/min <3.5 s @ 70 ml/min When measured with an adult watertrap and a 2.5m-long adult sampling line: <5 s @ 100 ml/min <6.5 s @ 70 ml/min
Apnea alarm delay	AwRR: 10 to 40 s
* Conditions for measurements in typical precision: The measurement is started after the preheating mode of the module; Ambient pressure: 750 mmHg to 760 mmHg; room temperature: 22°C to 28°C; The gas under test is dry, and the balance gas is N ₂ ; The deflation rate is 100 ml/min, the respiration rate is no greater than 50 BrPM, with a fluctuation less than ±3 BrPM, and the inhale interval/exhale interval is 1:2; When the working temperature is from 15 to 25 degree, or from 50 to 55 degree, or when the breath rate is greater than 50Brpm, the measurement precision should meet the requirements of ISO21647: ±4mmHg (0 to 40mmHg) or ±12% of the reading (41 to 99 mmHg)	

A.14.2 Oridion CO₂ Specifications

CO ₂ measurement range	0 to 99mmHg
Precision*	0 to 38 mmHg: ±2 mmHg 39 to 99 mmHg: ±5% + 0.08% × (reading - 38 mmHg)
Drift	meet the requirement of accuracy in 6 hours
Resolution	Waveform: 0.1 mmHg Value: 1 mmHg
Sample flow rate	50 ^{-7.5} ₊₁₅ ml/min
Initialization time	30 s (typical)
Response time	2.9 s (typical)
Delay time	2.7 s (typical)
AwRR measurement range	0 to 150 BrPM
AwRR measurement precision	0 to 70 BrPM: ±1 BrPM 70 to 120 BrPM: ±2 BrPM 121 to 150 BrPM: ±3 BrPM
Apnea alarm delay	AwRR: 10 to 40 s
* Precision applies for breath rates of up to 80 bpm. For breath rates above 80 bpm, accuracy complies with EN ISO 21647/ISO 21647/ISO 9918 (4 mmHg or ±12% of reading whichever is greater) for EtCO ₂ values exceeding 18 mmHg. To achieve the specified accuracies for breath rates above 60 breaths/minute, the Microstream® FilterLine H Set for Infant/Neonatal (p/n 006324) must be used. The accuracy specification is maintained to within 4% of the values indicated in the above table in the presence of interfering gases according to EN ISO 21647/ISO 21647 Section Eleven, Part 101.	

A.15 AG Specifications

Measurement technique	Infrared absorption		
Measurement mode	Sidestream		
AG functions	Meets requirements of ISO9918, ISO11196, EN12598 and ISO7767		
Warm-up time	45 seconds (warming-up status) 10 minutes (ready-to-measure status)		
Sampling flow (sidestream)	Adult/Pediatric	120, 150, 200 ml/minute (user-selectable)	
	Neonatal	70, 90, 120 ml/minute (user-selectable)	
Gas type	CO ₂ , N ₂ O, O ₂ (optional), Des, Iso, Enf, Sev, Hal		
Measurement range	CO ₂ :	0 to 30%	
	N ₂ O:	0 to 100%	
	Des:	0 to 30%	
	Sev:	0 to 30%	
	Enf, Iso, Hal:	0 to 30%	
	O ₂ :	0 to 100%	
	AwRR:	2 to 100 BrPM	
Resolution	CO ₂ :	1 mmHg	
	AwRR:	1 BrPM	
Precision	Gas	Range (%REL)	Precision (%ABS)
	CO ₂	0 to 1	±0.1
		1 to 5	±0.2
		5 to 7	±0.3
		7 to 10	±0.5
		> 10	Not specified
	N ₂ O	0 to 20	±2
		20 to 100	±3
	Des	0 to 1	±0.15
		1 to 5	±0.2
		5 to 10	±0.4
		10 to 15	±0.6
		15 to 18	±1
		>18	Not specified
	Sev	0 to 1	±0.15
		1 to 5	±0.2
		5 to 8	±0.4

		> 8	Not specified
	Enf, Iso, Hal	0 to 1	±0.15
		1 to 5	±0.2
		> 5	Not specified
	O2 (Optional)	0 to 25	±1
		25 to 80	±2
		80 to 100	±3
	AwRR	2 to 60 BrPM	±1 BrPM
> 60 BrPM		Not specified	
Drift	meet the requirement of accuracy in 6 hours		
Alarm range	CO2:	0 to 10 % (0 to 76 mmHg)	
	AwRR:	2 to 100 BrPM	
Apnea alarm delay	AwRR:	20 to 40 s	
Refreshing rate	1s		
Calibration	Yearly calibration requested.		
Calibration stability	After module being used for 12 consecutive months, the error is < 1%		
Rise time (10 % to 90 %) Sampling flow 120ml/min, using the DRYLINE™ water trap and neonatal DRYLINE™ sampling line (2.5m)	CO2	250 ms (fall time 200 ms)	
	N2O	250 ms	
	O2	600ms	
	HAL, ISO, SEV, DES	300 ms	
	ENF	350 ms	
Rise time (10 % to 90 %) Sampling flow 200ml/min, using the DRYLINE™ water trap and adult DRYLINE™ sampling line (2.5m)	CO2	250 ms (fall time 200 ms)	
	N2O	250 ms	
	O2	500ms	
	HAL, ISO, SEV, DES	300 ms	
	ENF	350 ms	
Delay time	< 4s		

* Accuracy applies for the following conditions:

1. Measurements begin after the module warms up;
2. Ambient pressure is from 750 to 760 mmHg, and ambient temperature from 22 to 28°C;
3. The measured gas is a dry gas and the balance gas N₂;
4. Gas sample flow rate is 120 ml/min, respiration rate is 20 rpm with a fluctuation between ±3 rpm, and I:E is 1:2.

Effect of interference gases on AG measurements					
Gas	Concentration(%)	Quantitative effect(% _{ABS}) ³⁾			
		CO ₂	N ₂ O	Agent ¹⁾	O ₂
CO ₂	/	/	0.1	0	0.2
N ₂ O	/	0.1	/	0.1	0.2
Agent ¹⁾²⁾	/	0.1 ⁵⁾	0.1 ⁵⁾	0.1 ⁴⁾	1
Nitrogen	≤78%	0	0	0	0
Xenon	<100%	0.1	0	0	0.5
Helium	<50%	0.1	0	0	0.5
Ethanol	<0.1%	0	0	0	0.5
Acetone	<1%	0.1	0.1	0	0.5
Methane	<1%	0.1	0.1	0	0.5
Saturated Isopropanol vapour	/	0.1	0	0	0.5
Metered dose inhaler propellants,	/	Unspecified	Unspecified	Unspecified	0.5
Methoxyflurane	/	Unspecified	Unspecified	Unspecified	Unspecified

1) Agent represents one of Des, Iso, Enf, Sev, and Hal.
2) Multiple agent interference on CO₂, N₂O and O₂ is typically the same as single agent interference.
3) For CO₂, N₂O and Agents, maximum interference from each gas at concentrations within specified accuracy ranges for each gas. The total interference of all gases is never larger than 5%_{REL}.
4) Only applicable for AION 03-type module, meaning the secondary agent interference on the primary one.
5) For AION 02-type module, it is the interference provided that input of used anaesthetic agent has been done.

FOR YOUR NOTES

B EMC

The equipment meets the requirements of EN 60601-1-2.

NOTE

- Use of accessories, transducers, and cables other than those specified may result in increased emission and/or decreased immunity of the equipment.
- The equipment should not be used adjacent to or stacked with other equipment, and if adjacent or stacked use is necessary, the equipment should be observed to verify normal operation in the configuration in which it will be used.
- The equipment needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided below.
- The equipment may be interfered with by other equipment, even if that other equipment complies with CISPR emission requirements.
- Operation of the device, in the case that the patient physiological signal is lower than the minimum amplitude and/or value specified in the product specifications, may cause inaccurate results.

TABLE 1

Guidance and declaration — electromagnetic emissions		
The equipment is intended for use in the electromagnetic environment specified below. The customer or the user of the equipment should assure that it is used in such an environment.		
Emissions test	Compliance	Electromagnetic environment — guidance
RF emissions CISPR 11	Group1	The equipment uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class A	The equipment is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic Emissions IEC61000-3-2	Class A	
Voltage Fluctuations/Flicker Emissions IEC 61000-3-3	Compliance P_{st} , T_{dt} (ms) D_{max} (%) Dc (%)	

TABLE 2

Guidance and declaration — electromagnetic immunity			
The equipment is intended for use in the electromagnetic environment specified below. The customer or the user of the equipment should assure that it is used in such an environment.			
Immunity test	IEC 60601 Test level	Compliance level	Electromagnetic environment — guidance
Electrostatic Discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast Transient/burst IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines (>3m).	±2 kV for power supply lines ±1 kV for input/output lines (>3m)	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1 kV differential mode ±2 kV common mode	±1 kV different mode ±2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, Short interruptions and voltage variation on power supply input lines IEC 61000-4-11	<5% U_T (>95% dip in U_T) for 0.5 cycle 40% U_T (60% dip in U_T) for 5 cycle 70% U_T (30% dip in U_T) for 25 cycle <5% U_T (>95% dip in U_T) for 5 sec	<5% U_T (>95% dip in U_T) for 0.5 cycle 40% U_T (60% dip in U_T) for 5 cycle 70% U_T (30% dip in U_T) for 25 cycle <5% U_T (>95% dip in U_T) for 5 sec	Mains power quality should be that of a typical commercial or hospital environment. If the user of our product requires continued operation during power mains interruptions, it is recommended that our product be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 HZ) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.

U_T is the A.C. mains voltage prior to application of the test level.

TABLE 3


Guidance and declaration — electromagnetic immunity			
The equipment is intended for use in the electromagnetic environment specified below. The customer or the user of the equipment should assure that it is used in such an environment			
Immunity test	IEC 60601 Test level	Compliance level	Electromagnetic environment — guidance
Conducted RF IEC 61000-4-6	3 Vrms 150kHz to 80MHz	3 Vrms	<p>Portable and mobile RF communications equipment should be used no closer to any part of the equipment, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.</p> <p>Recommended separation distance</p> $d = 1.2 \times \sqrt{P}$ $d = 1.2 \times \sqrt{P} \quad 80 \text{ MHz to } 800 \text{ MHz}$ $d = 2.3 \times \sqrt{P} \quad 800 \text{ MHz to } 2.5\text{GHz}$ <p>where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m).</p> <p>Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,^a should be less than the compliance level in each frequency range^b Interference may occur in the vicinity of equipment marked with the following</p> <p style="text-align: center;">  symbol: </p>
Radiated RF IEC 61000-4-3	3 V/m 80MHz to 2.5GHz	3V/m	
<p>Note — At 80 MHz and 800 MHz, the higher frequency range applies.</p> <p>Note — These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.</p>			
<p>^a Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the equipment is used exceeds the applicable RF compliance level above, the equipment should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the equipment.</p> <p>^b Over the frequency ranges 150kHz to 80MHz, field strengths should be less than 3V/m.</p>			

TABLE 4

Recommended separation distances between portable and mobile RF communication and the equipment			
The equipment is intended for use in an electromagnetic environment in which radiated RF disturbance are controlled. The customer or the user of the equipment can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communication equipment (transmitters) and the equipment as recommended below, according to the maximum output power of the communication equipment.			
Rated Maximum Output power of Transmitter W (Watts)	Separation Distance According to Frequency of Transmitter M (Meters)		
	150kHz -80MHz $d = 1.2\sqrt{P}$	80MHz -800MHz $d = 1.2\sqrt{P}$	800MHz -2.5GHz $d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.37	0.37	0.74
1	1.17	1.17	2.34
10	3.69	3.69	7.38
100	11.67	11.67	23.34
For transmitters at a maximum output power not listed above, the recommended separation distanced in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer. Note — At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies. Note — These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			

C Alarm Messages and Prompt Information

NOTE

- Your patient monitor may not include all the information listed in this section.

C.1 Physiological Alarm Messages

Note: XX represents the parameters being monitored, such as HR, RR, SpO₂, etc. The “L” field indicates the alarm level, and 1 means high, 2 means medium, 3 mean low, * means the level is user-adjustable.

Alarm messages	L	Cause	Measure
XX TOO HIGH	2*	XX value exceeds the upper alarm limit.	Make sure the alarm limits are appropriate for the patient, and check the patient’s condition.
XX TOO LOW	2*	XX value exceeds the lower alarm limit.	
ECG LOST	1	The ECG signal is so weak that the monitor can’t perform ECG analysis.	Check the connection of the patient cable and lead wires, and then check the patient’s condition.
RESP ARTIFACT	1	The patient’s heartbeat interferes with his respiration. The respiration rate cannot be measured correctly.	
NO PULSE	1	The pulse signal of the patient is so weak that the monitor cannot perform pulse analysis.	
CO ₂ APNEA	1	No respiration signal is detect or the respiration signal of the patient is so weak that the monitor cannot perform respiration analysis.	
RESP APNEA	1		
ASYSTOLE	1*	The asystole arrhythmia event occurs to the patient.	
VFIB/VTAC	1*	The ventricular tachycardia or ventricular fibrillation arrhythmia event occurs to the patient.	
R ON T	2*	The R ON T arrhythmia event occurs to the patient.	
VT > 2	2*	The VT>2 arrhythmia event occurs to the patient.	
COUPLET	2*	The couplet arrhythmia event occurs to the patient.	

PVC	2*	The PVC arrhythmia event occurs to the patient.
BIGEMINY	2*	The bigeminy arrhythmia event occurs to the patient.
TRIGEMINY	2*	The trigeminy arrhythmia event occurs to the patient.
TACHY	2*	The patient is suffering from tachycardia.
BRADY	2*	The patient is suffering from bradycardia.
PNC	2*	No pacer signal is captured.
PNP	2*	The pacemaker is not paced.
MISSED BEATS	2*	The arrhythmia event of missed beats occurs to the patient.
IRREG RHYTHM	2*	Irregular rhythm occurs to the patient.
VENT RHYTHM	2*	Ventricular rhythm occurs to the patient.
MULTIF. PVC	2*	Multiform PVCs occur to the patient.

C.2 Technical Alarm Messages

Note: XX represents the parameter modules like ECG, NIBP and SpO₂, or the parameters being monitored like HR, PR and SpO₂.

The A field indicates whether an alarm can be completely cleared; the B field indicates whether only visual and audible indications of an alarm can be cleared; the “L” field indicates the alarm level, and 1 means high, 2 means medium, 3 mean low, * means the level is user-adjustable.

C.2.1 General Alarm Messages of Parameter Modules

Alarm message	A	B	L	Cause	Measure
XX INIT ERR N	Yes	No	1	XX module initialization error N	Restart the monitor. If the error remains, contact our company for repair.
Note: N stands for the error number.					
XX COMM STOP	No	No	1	Failure in communication between XX module and the main board.	
XX COMM ERR	Yes	No	1	Error in communication between XX module and the main board.	
XX COMM ABNORMAL	No	No	1	The communication between XX module and the main board is abnormal.	If the error remains, contact our company for repair.
XX ALM LMT ERR	No	No	1	The alarm limit of the XX parameter is changed inadvertently.	
XX EXCEED	No	No	1	The measured XX parameter value exceeds the measurement range.	

C.2.2 ECG Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
ECG LEAD OFF	No	Yes	3	The ECG lead is not connected correctly.	Check for correct connection of the leadwires.
ECG X LEAD OFF	No	Yes	3		
Note: X represents the leadwires, V, LL, RL, LA and RA, as per AHA standard, or C, L, F, R and N as per IEC standard.					
ECG NOISE	No	No	3	Large interference signals appear on the ECG signal.	Make sure the leadwires are correctly connected. Check the patient for severe motion.
ECG CH1 SELFTEST ERR	Yes	No	1	An error occurs in the ECG initialization.	Restart the monitor. If the error remains, contact our company for repair.
ARTIFACT	Yes	No	1	Artifacts are detected on analysis lead, resulting in HR unable to be calculated, asystole, missed beats and ventricular fibrillation unable to be analyzed.	Check the connection between the electrode and the lead wire; check if there is an interference source near the electrode and the lead wire; check if the patient makes excessive motion.
HIGH FREQUENCY NOISE	Yes	No	1	The monitor is interfered by electromagnetic signals emitted by other radio equipment	Check if other radio equipment is located nearby.
LOW FREQUENCY NOISE	Yes	No	1		
ECG Signal Too Weak	No	No	1	The ECG signal is too weak to be detected.	Select a lead with better ECG signal output. Check the placement of the electrode or replace the leadwire.

C.2.3 RESP Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
RESP DISTURBED	No	No	3	The module circuit is disturbed.	If the problem occurs continuously, restart the monitor. If it still exists, contact our company for repair.
RR EXCEED	No	No	1	The circuit is disturbed and the measurement is inaccurate.	

C.2.4 TEMP Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
TEMP1 SENSOR OFF	No	Yes	3	The T1 sensor is not connected correctly to the patient or the monitor.	Check for correct connection of the T1 sensor.
TEMP2 SENSOR OFF	No	Yes	3	The T2 sensor is not connected correctly to the patient or the monitor.	Check for correct connection of the T2 sensor.
TEMP SELFTEST ERROR	No	No	1	Circuit fault of the temperature channel.	Contact our company for repair.
TEMP CALIBRATION ERR	No	No	2	Error in temperature channel calibration.	Restart the monitor. If the error remains, contact our company for repair.

C.2.5 NIBP Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
NIBP SELFTEST ERR	Yes	Yes	1	Error in NIBP initialization.	Select RESET from the NIBP SETUP menu. If the error remains, contact our company for repair.
LOOSE CUFF	No	Yes	3	The NIBP cuff is not properly connected.	Check the patient's condition, and check if the patient type is correct. Replace with a proper cuff and connect it correctly. If the problem still exists, contact our company for repair.
AIR LEAK	No	Yes	3	Leak in the airway.	
PNEUMATIC LEAK	No	Yes	3		
CUFF TYPE ERR	No	Yes	2	The cuff applied is not appropriate to the patient type.	
AIR PRESSURE ERROR	No	Yes	3	Failure occurs in the pulse measurement. The monitor cannot perform measurement, analysis, or calculation.	
WEAK SIGNAL	No	Yes	3		
SIGNAL SATUATED	No	Yes	3		
RANGE EXCEEDED	No	Yes	3		Check the patient's condition, and check if the patient type is correct. Replace with a proper cuff and connect it correctly. If the problem still exists, contact our company for
EXCESSIVE MOTION	No	Yes	3	Excessive motion of the patient's arms.	Replace with a proper cuff and connect it correctly. If the problem still exists, contact our company for
OVER PRESSURE	No	Yes	2	The airway might be blocked.	

Alarm message	A	B	L	Cause	Measure
NIBP SYSTEM FAILURE	No	Yes	2	Failure occurs in the pulse measurement. The monitor cannot perform measurement, analysis, or calculation.	repair.
NIBP TIME OUT	No	Yes	2		
MEASURE FAIL	No	Yes	2		
NIBP ILLEGALLY RESET	No	Yes	2	Illegal reset comes out during the NIBP measurement.	Check if the airway is blocked. Deal with the blocking and perform the measurement again. If the problem still exists, contact our company for repair.

C.2.6 Mindray DS SpO₂ Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
SPO2 SENSOR OFF	No	Yes	3	The sensor is disconnected from the patient or the monitor.	Make sure the sensor is placed on the patient's finger or other parts, and the monitor is connected to cables correctly.
SPO2 NO SENSOR	Yes	Yes	3	The sensor is disconnected from the patient or the monitor, or it is not properly connected.	Disconnect and reconnect the sensor as directed by the instructions. If the alarm remains, the sensor or the cable might have been damaged.
				The SpO ₂ is connected upside down.	Disconnect and reconnect the sensor as directed by the instructions. Pay attention to the mark on the probe.
SPO2 LOW PERFUSION	No	No	3	The pulse signal is too weak.	Move the sensor to a site with better perfusion.

C.2.7 Nellcor SpO₂ Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
SPO2 SENSOR OFF	No	Yes	3	The sensor is disconnected from the patient or the monitor.	Make sure the sensor is placed on the patient's finger or other parts, and the monitor is connected to cables correctly.
SPO2 NO SENSOR	Yes	Yes	3	The sensor is disconnected from the patient or the monitor, or the sensor is not connected properly.	Disconnect and reconnect the sensor as directed by the instructions. If the alarm remains, the sensor or the cable might have been damaged.
				The SpO2 probe is inserted upside down.	Disconnect and reconnect the sensor as directed by the instructions. Pay attention to the mark on the probe.
SPO2 INTERFERENCE	No	No	3	The pulse signals are subject to great external interference.	Reduce or remove external interference.
SPO2 BOARD FAULT	No	No	1	The SpO2 set board malfunctions and might be unable to measure the pulse signals correctly.	Stop using the SpO2 module, and contact biomedical engineers or our company for maintenance.
SPO2 MOTION	No	No	3	The patient is moving.	Reduce patient motion.
SPO2 SENSOR FAULT	No	No	1	The probe is damaged.	Stop using the sensor.
SPO2 WEAK SIGNAL	No	No	3	The SpO2 signal is weak.	Change the sensor site for better signals.
SPO2 WEAK PULSE	No	No	3	The detected pulse signal is too weak.	

C.2.8 IBP Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
IBP1 SENSOR OFF	No	Yes	3	The invasive blood pressure cable of channel 1 is disconnected from the monitor.	Check if the IBP 1 sensor is properly connected.
IBP2 SENSOR OFF	No	Yes	3	The invasive blood pressure cable of channel 2 is disconnected from the monitor.	Check if the IBP 2 sensor is properly connected.
IBP1 NEED ZERO-CAL	No	No	3	The IBP transducer of channel 1 has not been zeroed.	Zero the IBP transducer of channel 1.
IBP2 NEED ZERO-CAL	No	No	3	The IBP transducer of channel 2 has not been zeroed.	Zero the IBP transducer of channel 2.

C.2.9 CO Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
TB SENSOR OFF	No	Yes	3	The cable for blood pressure measurement is disconnected from the monitor.	Check for proper connection of TB cable.

C.2.10 Mindray DS CO₂ Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
CO2 NO WATERTRAP	No	No	2	The water trap is not properly connected or is disconnected.	Make sure the sidestream CO ₂ water trap is firmly connected.
CO2 SENSOR TEMP HIGH	No	No	1	The temperature of the sensor assembly is too high.	Restart the monitor if necessary. If the problem remains, contact our company for repair.
CO2 SENSOR TEMP LOW	No	No	1	The temperature of the sensor assembly is too low.	
CO2 AIRWAY PRES TOO HIGH	No	No	2	The pressure inside the airway is too high.	
CO2 AIRWAY PRES TOO LOW	No	No	2	The pressure inside the airway is too low.	

Alarm message	A	B	L	Cause	Measure
CO2 BAROMETRIC TOO HIGH	No	No	2	The barometric pressure is too high.	
CO2 BAROMETRIC TOO LOW	No	No	2	The barometric pressure is too low.	
CO2 HARDWARE ERROR	No	No	1	AD sampling 2.5V error	
CO2 HARDWARE ERROR	No	No	1	The pump malfunctions.	
CO2 HARDWARE ERROR	No	No	1	The 3-way stopcock malfunctions.	
CO2 SAMPLE LINE ABNORMAL	No	No	2	The sample line is abnormal or blocked.	Make sure the airway is not blocked. If the problem still exists, contact our company for repair.
CO2 CALIBRATE ZERO ERROR	No	No	1	Zeroing failure.	Restart the monitor. If the problem still exists, contact our company for repair.
CO2 USER CALIBRATE FAIL	No	No	2	User calibration failure.	Make sure the preset calibration gas concentration consists with the input calibration gas. If the problem remains, contact our company for repair.
CO2 SYSTEM ERROR	No	No	1	EEPROM reading address error.	Contact our company for repair.
CO2 SYSTEM ERROR	No	No	1	EEPROM reading length error.	
CO2 SYSTEM ERROR	No	No	1	EEPROM response to component error.	
CO2 SYSTEM ERROR	No	No	1	EEPROM checksum error.	
CO2 SYSTEM ERROR	No	No	1	External AD sample line error.	
CO2 SYSTEM ERROR	No	No	1	Internal AD sample line error.	
CO2 SYSTEM ERROR	No	No	1	Self-test error	
CO2 COMM ERROR	Yes	No	1	CO2 module communication fault.	Restart the monitor. If the problem still exists, contact

Alarm message	A	B	L	Cause	Measure
CO2 INIT ERR	Yes	No	1	The CO2 module is not properly installed, or malfunctions.	our company for repair.
CO2 COMM STOP	No	No	1	CO2 module fault or communication fault.	

C.2.11 Oridion CO₂ Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
CO2 CHECK CALIBRATION	No	No	2	Calibration error	Make sure the calibration gas is proper.
CO2 CHECK FLOW	No	No	2	Airway error	Check for leaks in the airway.
CO2 OCCLU. IN GAS LINE	No	No	2	The sampling airway has been occluded for a period of time.	
CO2 FILTERLINE OFF	No	No	2	The filter Line cannot be detected.	Check if the filter line is properly connected.
CO2 OVER RANGE	No	No	2	The CO ₂ concentration value exceeds the measurement range.	Check the input gas.
CO2 REPLACE MAIN BOARD	No	No	1	CO ₂ module fault.	Contact our company.
CO2 CHECK SENSOR OR PCB	No	No	1		
CO2 REPL SCRUBBER+PUMP	No	No	1		
CO2 CHANGE SENSOR	No	No	1		
CO2 15VOLT OUT OF RANGE	No	No	1		
CO2 TEMP OVERRANGE	No	No	1	The temperature of CO ₂ module overranges.	Restart the monitor if necessary. If the problem remains, contact our company for repair.

Alarm message	A	B	L	Cause	Measure
CO2 CALIB ERROR	No	No	2	Including the error messages displayed at the lower part of the menu (like gas error, measurement error, zeroing failure, etc.)	Take measures specific to the errors. For instance, in case of a gas error, check if the gas concentration is wrong. A measurement error indicates the module is removing the occlusion or the filter line is not connected properly.
CO2 INIT ERR	Yes	No	1	An error occurs during the CO2 initialization.	Restart the monitor. If the error remains, contact our company for repair.
CO2 COMM STOP	No	No	1	Failure in communication between the CO2 module and the main board.	
CO2 COMM ERR	Yes	No	1	Error in communication between the CO2 module and the main board.	

C.2.12 AG Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
AG SENSOR OFF	No	Yes	3	The AG sensor is not properly connected or is disconnected.	Make sure the AG sensor is properly connected.
AG NO WATERTRAP	No	Yes	3	The AG water trap is disconnected from the monitor.	Make sure the water trap is properly connected.
CHANGE AG WATERTRAP	Yes	No	2	The AG water trap is replaced.	Wait until the water trap has been changed.
AG WATERTRAP TYPE WRONG	Yes	No	2	The AG water trap is of a wrong type.	Replace with a water trap of a correct type.
AG USA ERROR	Yes	No	2	AG module fault.	Contact us to get rid of the fault.
AG PARAMAGNETIC O2 ERR	Yes	No	2	O ₂ module fault.	Contact us to get rid of the fault.
AG GALVANIC O2 ERROR	Yes	No	1		
AG OXIMA DEPLETION WARN	Yes	No	2		
AG OXIMA DEPLETION ERR	Yes	No	2		
AG OCCLUSION	Yes	No	1	The actual pump rate of the AG module is <20ml/min, which	Remove the block of the airway.

				exceeds 1 second.	
AG SELF-TEST ERR	Yes	No	1	AG module fails or fails to communicate with the host.	Unplug and re-plug the module and then restart the monitor, or plug the AG module in another monitor to check if it operates properly.
AG HARDWARE MALF	No	No	1	AG module hardware failure. The module enters the standby mode or stop AG monitoring.	Remove the AG module from the monitor and send for authorized maintenance personnel.
AG HARDWARE ERROR	Yes	No	2	AG module hardware fault. The module remains AG monitoring.	Unplug and re-plug the module and then restart the monitor.
AG DATA LIMIT ERROR	Yes	No	2	AG module fault.	
AG ZREF FAIL	Yes	No	3	Failure in AG module zeroing.	
AG CAL FAIL	Yes	No	1	Failure in AG module calibration.	
CO2 ACCURACY UNSEPCIFIED	Yes	No	3	The measurement is out of specified range at specified accuracy.	
N2O ACCURACY UNSEPCIFIED	Yes	No	3		
O2 ACCURACY UNSEPCIFIED	Yes	No	3		
HAL ACCURACY UNSEPCIFIED	Yes	No	3		
ENF ACCURACY UNSEPCIFIED	Yes	No	1		
ISO ACCURACY UNSEPCIFIED	Yes	No	3		
SEV ACCURACY UNSEPCIFIED	Yes	No	3		
DES ACCURACY UNSEPCIFIED	Yes	No	3		
AwRR ACCURACY UNSEPCIFIED	Yes	No	3		

C.2.13 Recorder Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
RECORDER INIT ERR N	Yes	No	2	An error occurs during the recorder initialization.	Contact the hospital's engineers or our customer Service.
Note: N represents the error number.					
RECORDER SELFTEST ERR	Yes	No	2	An error might occur to the RAM, ROM and CPU watchdog.	Open the RECORD menu and select the CLEAR REC TASK option. If the problem remains, contact our company for repair.
RECORDER VLT HIGH	No	No	1	A problem occurs to the system power.	If this alarm message is given for many times, contact our company for repair.
RECORDER VLT LOW	No	No	1		
RECORDER HEAD HOT	No	No	1	The thermal head of the recorder is too hot.	Resume the recording till the recorder cools down completely. If the problem still exists, contact our company for repair.
REC HEAD IN WRONG POS.	Yes	Yes	3	The thermal head of the recorder is in wrong position.	Restore the control lever of the recorder to its previous position.
RECORDER OUT OF PAPER	Yes	Yes	3	The recorder paper is used up.	Replace with a new paper roll.
RECORDER PAPER JAM	No	No	2	The recording continues for more than 30 minutes.	Place the recorder correctly and try again.
RECORDER COMM ERR	Yes	No	2	Error in recorder communication.	Open the RECORD menu and select the CLEAR REC TASK option. If the problem remains, contact our company for repair.
TOO MANY REC TASKS	No	No	2	Quite a few alarm events occur at the same time.	Check the patient's condition and the alarms. Open the RECORD menu and select the CLEAR REC TASK option. If the problem remains, contact our company for repair.
RECORDER PAPER W.P.	Yes	Yes	2	The paper roll of the recorder is not placed in the correct position.	Place the paper roll correctly.
RECORDER S. COMM ERR	Yes	No	2	Error in recorder communication.	Open the RECORD menu and select the CLEAR REC TASK option. If the problem remains, contact our company for repair.
REC NOT AVAILABLE	No	No	2	Error in the recorder work mode.	

C.2.14 System Alarm Messages

Alarm message	A	B	L	Cause	Measure
REAL CLOCK NEED SET	No	No	1	The system time is incorrect.	Reset the system time and then restart the monitor.
REAL CLOCK NOT EXIST	No	No	1	No button battery, or the battery power is depleted.	Add, or replace with a new button battery.
KEYBOARD INIT ERR N	No	No	1	Keyboard error. The keyboard cannot be used.	Contact our company for repair.
Note: N represents the error number.					
KEYBOARD ERROR	No	No	2		
NET INIT ERR (G.)	No	No	2	The system cannot be connected to the network due to problems in the monitor's network part.	
NET INIT ERR (Ram)	No	No	2		
NET INIT ERR (Reg)	No	No	2		
NET ERR (Run 1)	No	No	2		
NET ERR (Run 2)	No	No	2		
12V TOO HIGH	No	No	1	A problem occurs to the system power.	If this alarm message is given for many times, contact our company for repair.
12V TOO LOW	No	No	1		
BATTERY TOO LOW	No	No	1	The battery voltage is too low.	Connect the monitor with AC power to recharge the battery.

C.3 Prompt Messages

Prompt messages	Cause	Measure
ECG1 SIGNAL SATURATION	Signals of abrupt change interfere with the ECG signal.	Check whether the electrodes and leads are well connected.
ECG2 SIGNAL SATURATION		
SEARCH PULSE	The SpO ₂ module is searching the pulse.	Wait till the end of the searching.
DOMINANT RHYTHM CHANGE	A change happens to the patient's dominant rhythm.	None.
Mindray DS CO₂ module		
CO ₂ STANDBY	The CO ₂ module enters the energy-saving status when switching from the Normal mode to the Standby mode.	None
CO ₂ START UP	The CO ₂ module is starting.	Wait for the CO ₂ module to finish the startup.
CO ₂ CALIBRATE ZERO	The CO ₂ module is in the zeroing status.	Wait for the CO ₂ module to finish the zeroing.
CO ₂ WARM UP	The CO ₂ module is warming itself up after startup.	Wait for the CO ₂ module to finish warming itself up.
Oridion CO₂ module		
CO ₂ STANDBY	The CO ₂ module enters the energy-saving status when switching from the Normal mode to the Standby mode.	None
CO ₂ START UP	The CO ₂ module is starting.	Wait for the CO ₂ module to finish the startup.
CO ₂ CALIBRATE ZERO	The CO ₂ module is in the zeroing status.	Wait for the CO ₂ module to finish the zeroing.
CO ₂ SENSOR START UP	The CO ₂ sensor is warming itself up after startup.	Wait for the CO ₂ module to finish warming itself up.
CO ₂ CALIBRATE	The CO ₂ module is in the calibrating status.	Wait for the CO ₂ module to finish the calibration.
CO ₂ PURGING	The CO ₂ module is in the purging status.	Wait for the CO ₂ module to finish the purging.
Recorder		
RECORDER INITIALIZING	The recorder is in the initializing status.	Wait for the recorder to finish the initialization.
RECORDER BUSY	The recorder is recording.	Wait for the recorder to finish the recording.
AG module		
AG STANDBY	The AG module is in the standby mode.	None

Prompt messages	Cause	Measure
AG IS STARTING	The AG module is starting.	Wait for the AG module to finish the startup.
AG WARM UP	The AG module is warming itself up.	Wait for the AG module to finish warming itself up.
NIBP module		
Manual measure...	The NIBP module is performing the manual measurement.	Wait for the NIBP module to finish the measurement.
CONTINUAL...	The NIBP module is performing the continuous measurement.	
Auto measuring...	The NIBP module is performing the auto measurement.	
Resetting...	The NIBP module is being reset.	Wait the NIBP module to finish the resetting.
Resetting...		
Please start	This message appears after the auto measurement interval is selected.	Press the NIBP button to start the measurement.
CALIBRATE...	The NIBP module is performing the calibration.	Wait for the NIBP module to finish the calibration.
Calibration over	The calibration is finished.	None
PNEUMATIC...	The NIBP module is checking the pneumatic system for leakage.	Wait for the NIBP module to finish checking the pneumatic system.
Pneum test over	The NIBP finishes checking the pneumatic system for leakage.	None
Measurement over	The NIBP button is pressed during the measurement.	None
Reset failed	The reset fails.	None
ST LEARNING	The QRS complex template for the ARR analysis is forming.	Wait till the end of the ARR learning.
ARR LEARNING		
DEFIB. SYNC.ON	The DEFIB. SYNC. switch is turned on.	It indicates that the auxiliary output port is outputting DEFIB. SYNC. signals.

FOR YOUR NOTES

D Symbols and Abbreviations

Symbols and abbreviations that you may encounter while reading this manual or using the monitor are listed below with their meanings.

D.1 Symbols

A	ampere
Ah	ampere hour
bpm	beats per minute
BrPM	breaths per minute
°C	centigrade
cc	cubic centimeter
cm	centimeter
dB	decibel
DS	dyne second
°F	fahrenheit
g	gram
GTT	gutta
hr	hour
hPa	hundred pascal
Hz	hertz
inch	inch
kg	kilogram
kPa	kilopascal
l	litre
lb	pound
m	meter
mcg	micrograms
mEq	milli-equivalents
mg	milligrams
min	minute
ml	milliliter
mm	millimeters

mmHg	millimeters of mercury
ms	millisecond
mV	millivolt
mW	milliwatt
nm	nanometer
ppm	part per million
s	second
V	volt
VA	volt ampere
Ω	ohm
μ A	microampere
μ m	micron
μ V	microvolt
W	watt
-	minus
%	percent
/	per; divide; or
^	power
+	plus
=	equal to
<	less than
>	greater than
\leq	less than or equal to
\geq	greater than or equal to
\pm	plus or minus
\times	multiply
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D.2 Abbreviations

AAMI	Association for Advancement of Medical Instrumentation
AC	alternating current
ADT	adult
AG	anaesthesia gas
AHA	American Heart Association
ANSI	American National Standard Institute
AP	access point
ARR	arrhythmia
ART	arterial
aVF	left foot augmented lead
aVL	left arm augmented lead
aVR	right arm augmented lead
AwRR	Air way respiratory rate
BSA	body surface area
BTPS	body temperature and pressure, saturated
CCU	critical care unit
CH	channel
CI	cardiac index
CISPR	International Special Committee on Radio Interference
CMS	central monitoring system
cmos	Complementary Metal Oxide Semiconductor
CO	cardiac output
CO ₂	carbon dioxide
COHb	carboxyhemoglobin
CPU	central processing unit
CVP	central venous pressure
D	diastolic
DC	direct current
DES	desflurane
DIA	diastolic
e.g.	for example
ECG	electrocardiograph
EEC	European Economic Community
EMC	electromagnetic compatibility
ENF	enflurane

ERR	error
ES	electrosuigical
ESU	electrosuigical unit
Et	end-tidal
EtCO ₂	end-tidal carbon dioxide
EtN ₂ O	end-tidal nitrous oxide
EtO	Ethylene Oxide
EtO ₂	end-tidal oxygen
EURO	European
Fi	fraction of inspired
FiCO ₂	fraction of inspired carbon oxygen
FiN ₂ O	fraction of inspired nitrous oxide
FiO ₂	fraction of inspired oxygen
fpga	Field Programmable Gate Array
HAL	halothane
Hb-CO	Carbon mono-oxide hemoglobin
HR	heart rate
HT	height
IBP	invasive brood pressure
ICP	intracranial pressure
ICT/B	intracranial catheter tip pressure transducer
IEC	International Electrotechnical Commission
ID	invasive diastolic brood pressure
IM	invasive mean brood pressure
IS	invasive systolic brood pressure
Ins, INS	Inspired Minimum
InsCO ₂	Inspired Minimum carbon dioxide
ISO	isoflurane
ISO	International organization for standardization
LA (L)	left arm
LAP	left atrial pressure
LCD	liquid crystal display
LED	light emitting diode
LL (F)	left leg
Loop	loop read-write test fail
M	mean

MAC	minimal alveolar concentration
MAP	mean arterial pressure
MDD	Medical Device Directive
MEAN	mean pressure
MetHb	methemoglobin
Mii	initialize MII registers fail
MRI	magnetic resonance imaging
N2O	nitrous oxide
N/A	not applied
NEO	neonate, neonatal
NIBP	noninvasive blood pressure
ND	non-invasive diastolic brood pressure
NM	non-invasive mean brood pressure
NS	non-invasive systolic brood pressure
O2	oxygen
oxyCRG	Oxygen Cardio-respirogram
P	power
PA	pulmonary artery
PD	photodetector
PED	pediatric
PLETH	plethysmogram
PM	Patient Monitor
PR	pulse rate
PVC	premature ventricular complex
QRS	interval of ventricular depolarization
RA (R)	right arm
RAM	random access memory
RAP	right atrial pressure
Reg	test NE2000 registers fail
RESP	respiration
RL (N)	right leg
ROM	read-only memory
RR	respiration rate
S	systolic
SEV	sevoflurane
SpO2	arterial oxygen saturation from pulse oximetry

SYNC	synchronization
SYS	systolic
T1	temperature of channel 1
T2	temperature of channel 2
TB	temperature of blood
TD	temperature difference
TEMP	temperature
TFT	Thin-Film Technology
TI	Temperature of Injectate
VGA	Video Graphic Array
WT	weight

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