

# CETUS x12 / x15

## MULTI-PARAMETER PATIENT MONITOR

### INSTRUCTIONS FOR USE

[Version 1.2]



# Notice

Thanks for purchasing Multi-parameter Patient Monitor.

Before operating, please read this Manual carefully to ensure proper use.

Please keep this Manual properly for future reference.

Product Type:	Patient Monitor
Model:	CETUS x12, CETUS x15
Structure and Components:	The monitor consists of master unit, display, ECG cable, SpO2 probe, blood pressure cuff, and temperature probe.
Scope of Application:	Monitors patient ECG, respiration (RESP), blood oxygen saturation (SpO2), pulse rate (PR), noninvasive blood pressure (NIBP), and temperature (TEMP) as well as displays, reviews and stores the monitoring information.
Manufacturer:	aXcent medical GmbH Josef-Görres-Platz 2 56068 Koblenz / Germany
Version:	1.2
Date of Issue:	October 2019

# Warranty and Maintenance Services

The warranty period is 2 years for this product and 1 year for the main accessories. The main accessories include: blood oxygen probe and extension cable, ECG cable, blood pressure cuff and catheter, temperature probe, power cord, stent, and ground wire. Consumables are disposable materials that should be replaced after each use or wearing parts that should be replaced periodically. The consumables are not covered by warranty.

The warranty period is counted from the “Installation Date” filled in the Warranty Card, which is the only certificate to check the period of warranty. To protect your rights, please urge your installation personnel to send the second copy of the Warranty Card to manufacturer within 30 days from the date of installation; if the Warranty Card for the product purchased is not sent to manufacturer on time, the warranty period will be calculated after 45 days from the “Delivery Date” marked on the packing box.

Manufacturer will be responsible for the safety, reliability and performance of the product if the following requirements are met:

- The product is used in accordance with the Operator’s Manual.
- Product installation, repair and upgrade are carried out by personnel approved or authorized by manufacturer.
- The storage, operating and electrical environment meets product specifications.
- The S/N label or manufacturer logo of the product is clearly visible, and it is identified and confirmed that the product is manufactured by manufacturer.
- The damage is caused by non-human factors (human factors include accidentally dropping, sabotage, etc.).

The products that meet the warranty regulations can enjoy free service, and the products beyond the scope of the warranty will be charged for service. The freight (including customs fees) for transport of this product to manufacturer for maintenance is assumed by the user. For the maintenance due to any reason other than the abovementioned causes, manufacturer will charge for service, and the user needs to pay additional costs for maintenance and parts.

When the warranty expires, manufacturer will continue to provide charged maintenance services.

If you do not pay or delay the payment of maintenance fees, manufacturer will suspend the repair services until you pay up.

# Preface

## Notice

This Operator's Manual is the necessary instructions for the safe use of this product. This Manual introduces the use, properties, method of operation, safety information and intended use of the Multi-parameter Patient Monitor in details. Before using the product, please carefully read and understand the contents of this Manual and abide by the method of operation stated in this Manual in order to ensure the safety of patients and operators.

This Operator's Manual is a major component of the product and should always be placed near the product for easy reference.

## Object of Application

This Operator's Manual is intended for professional clinical staff or personnel with experience in the use of monitoring equipment. The readers should have knowledge and work experience in medical procedures, practices and terminology of patient monitoring.

## Illustration

All the illustrations in this Operator's Manual are for reference only. The menus, settings and parameters of the illustrations may be different from the monitor.

## Convention

- [Character]: Used to represent the string in the software or characters on the interface.
- →: This symbol is used to indicate operation step.

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# Chapter 1. Safety

## 14.1 Safety Information



### **Danger**

- A warning that alerts you to a potential serious outcome, adverse event or safety hazard. Failure to observe a warning may result in serious injury or death to the user or patient.



### **Warning**

- Alerts you to potential hazard or unsafe operation. Failure to avoid such hazard or operation may result in minor or moderate personal injury or damage to the product or other properties, and possibly in a remote risk of more serious injury.



### **Caution**

- In order to safely use the device continuously, it is required to comply with the instructions listed. The instructions listed in this Manual are not substitute for the medical procedure being performed.

### **Note**

- Emphasize important considerations and provide a description or explanation in order to make better use of the product.
- In order to safely use the device continuously, it is required to comply with the instructions listed. The instructions listed in this Manual are not substitute for the medical procedure being performed.

### 14.1.1 Danger

This product does not involve information of danger levels.

### 14.1.2 Warning

- This monitor is used for clinical patient monitoring, and only trained and qualified doctors and nurses are allowed to use this monitor.
- Before operating, the user must check if the device, cables and accessories are functioning properly and safely.
- The alarm volume, upper and lower alarm limit should be set according to the actual situation of the patient. Do not just rely on audio alarm system while monitoring the patient, because too low alarm volume or complete shutdown may result in alarm failure and endanger the patient safety. Please pay close attention to the actual clinical situation of the patient.

- **This device can only be connected to a grounded electrical outlet; if the power outlet is not connected to the ground wire, do not use the outlet; instead, supply power to the device with rechargeable batteries.**
- **Do not open the enclosure in order to avoid an electric shock. Any repair and upgrade of the monitor must be done by service personnel trained and authorized by manufacturer.**
- **When handling packaging materials, abide by local laws and regulations or hospital waste disposal regulations. Keep the packaging materials away from children.**
- **Do not use this instrument at a place with inflammables such as anesthetics to prevent explosion or fire.**
- **Please install the power lines and cables of accessories carefully to avoid patient entanglement or suffocation, cables tangled or electrical interference.**
- **The devices connected to the monitor should form an equipotential body (protective grounding effectively connected).**
- **When the monitor is used together with electrosurgical devices, the user (a doctor or a nurse) should ensure the safety of the patient and instrument.**
- **The physiological wave, physiological parameters and alarm information displayed on the monitor are only for the doctor's reference and should not be directly used as the basis for clinical treatment.**
- **This is not a therapeutic unit.**
- **For patients with pacemakers, the cardiometer may count the pacemaker pulse in case of a cardiac arrest or arrhythmias. Never rely solely on the cardiometer alarm. Closely monitor the patients with pacemakers. For the inhibition of the device on pacemakers, refer to this Operator's Manual.**

### 14.1.3 Caution

- **To avoid damage to the instrument and to ensure patient safety, please use the accessories specified in this Manual.**
- **Please install or carry the instrument properly to prevent damage due to falling, collision, strong vibration or other mechanical force.**
- **The electromagnetic fields may affect the performance of the instrument, so that using other devices in the vicinity of this instrument must comply with relevant EMC requirements. For example: mobile phone, X-ray or MRI equipment is likely to be a source of interference, since they will transmit high intensity electromagnetic radiation.**
- **Before powering on the device, make sure that the power used by the device complies with the supply voltage and frequency requirements on the equipment label or in the Operator's Manual.**
- **When the instrument and accessories are about to exceed the useful life, it must be treated in accordance with relevant local laws and regulations or the hospital's rules and regulations.**

### 14.1.4 Note

- **Install the device at a place easy for observation, operation and maintenance.**
- **Keep this Manual near the instrument for easy reference.**
- **The instrument should be used only by one patient at the same time.**

## 14.2 Symbols

The symbols appearing on the instrument are as follows:

	Defibrillation-proof type CF applied part		Auxiliary output interface
	Defibrillation-proof type BF applied part		USB interface
	Caution: Refer to accompanying documents (Operator's Manual).		Network Interface
	Power on / off		Signal input and output interface
	AC power supply (AC)		Display Interface
	Battery operating indicator		Equipotential terminal
	Alarm silence		Serial Number
	NIBP		Production date
	Wave freezing		Manufacturer info
	Print		Waste Electrical and Electronic Equipment Directive
	Refer to the Operator's Manual		

## Chapter 2. Monitor Overview

### 2.1 Introduction

#### 2.1.1 Scope of Application

This monitor is suitable for bedside monitoring for adults, pediatric and neonatal application. This monitor enables ECG, respiration (RESP), pulse rate (PR), blood oxygen saturation (SPO2), noninvasive blood pressure (NIBP), and temperature (TEMP) monitoring. It is equipped with a replaceable built-in battery to provide convenience for the patient movement in hospital.

#### 2.1.2 Contraindications

None.

#### 2.1.3 Composition and Structure

The monitor consists of master unit, display, ECG cable, SpO2 probe, blood oxygen cuff, temperature probe, and built-in lithium battery.

### 2.2 Master Unit

#### 2.2.1 Front View

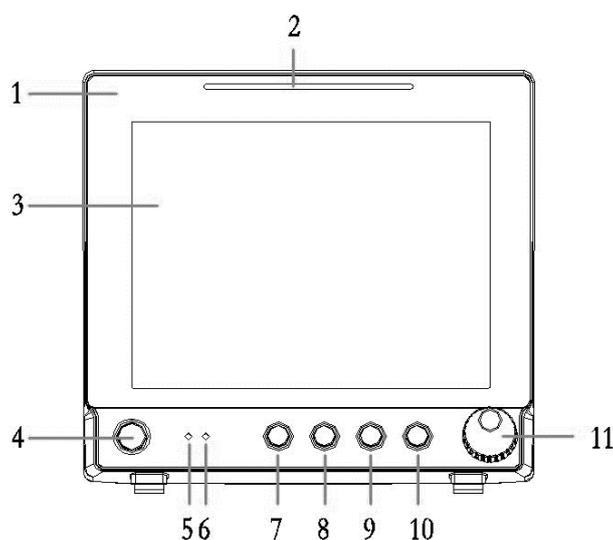


Fig. 2-1 Front View

1. Company logo
2. Alarm indicator

The alarm indicator indicates the levels of physiological alarms and technical alarms in different colors and flashing frequencies:

  - High: red, fast flashes
  - Medium: yellow, slow flashes
  - Low: yellow, lit without flashing.
3. Display
4. Power on / off button
  - Power on: When the monitor has been connected to AC power supply, press this key to turn on the monitor.
  - Power off: In power on state, press and hold this key for two seconds to turn off the monitor.
  - The key integrates indicator, which is lit when the monitor is turned on and off when the monitor is turned off.
5. AC power indicator
  - On: The monitor has been connected to AC power.
  - Off: The monitor has not been connected to AC power.
6. Battery indicator
  - On: The battery is being charged or has been fully charged.
  - Off: The battery has not been installed, or the battery has been installed but the AC power is not connected and the monitor is not turned on.
  - Flashing: The monitor is being powered by the battery.
7. Silence key: Press this key to turn off/resume the alarm sound of the system.
8. NIBP measurement start / stop key: press this key to start / stop the measurement of non-invasive blood pressure.
9. Freeze key: Press this key to freeze / unfreeze the wave.
10. Print key
11. Shuttle

Shuttle can be used to perform the following operations:

  - Rotate: Rotate clockwise or counterclockwise to move the focus.
  - Press: Press the knob to perform an action, such as access to a menu or execute a command.

## 2.2.2 Side View

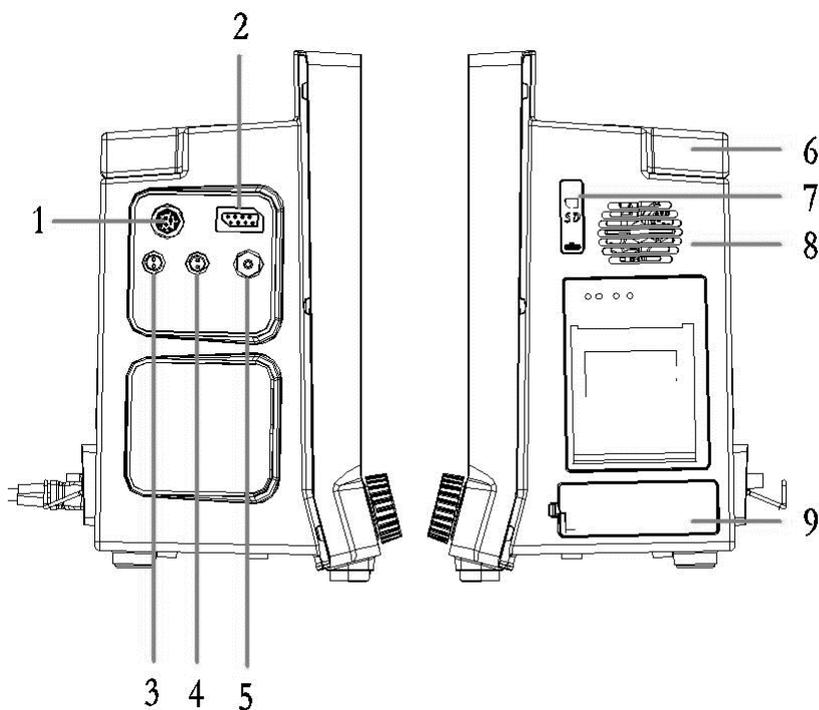


Fig. 2-2 Side View

1. ECG — ECG cable interface
2. SpO2 — SpO2 cable interface
3. T1 — Temperature probe interface
4. T2 — Temperature probe interface
5. NIBP — NIBP cuff interface
6. Movable handle
7. SD card slot
8. Fan outlet
9. Battery cover

## 2.2.3 Rear View

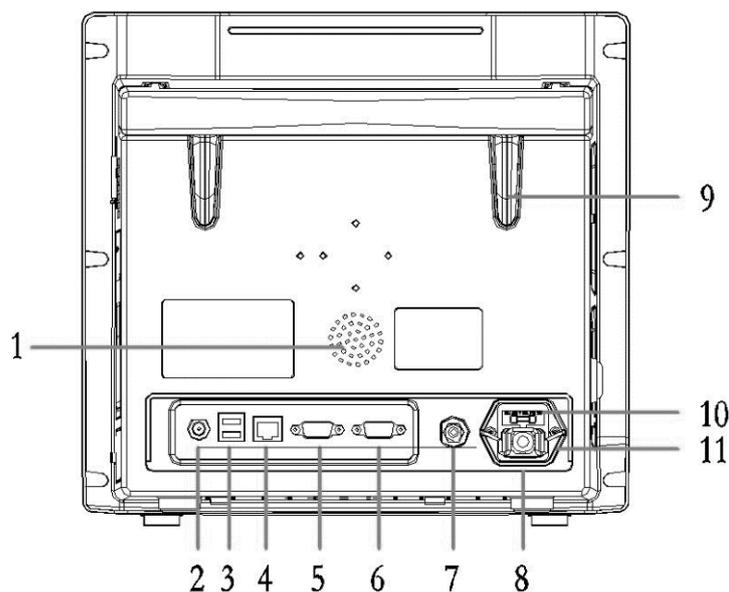


Fig. 2-3 Rear View (example)

1. Speaker holes
2. Auxiliary output interface (nurse call, unrealized)
3. USB interfaces (2): Connect an external storage device to upgrade the monitor software.
4. Network interface
5. Signal input and output interface: standard DB9 interface, which can be connected to the PC to output data or connected with a compatible device.
6. Display interface: Connected to a standard color VGA monitor for auxiliary display and monitoring. External monitor displays the same content as the monitor display.
7. Equipotential terminal: When other devices are used in conjunction with the monitor, you should connect the equipotential terminals of other devices and the monitor with wires to eliminate the ground potential difference between different devices and ensure safety.
8. Power cord retaining hook
9. Hook
10. Fuse
11. AC power socket

## 2.3 Screen Display

The monitor uses high-resolution color TFT LCD, which can clearly show the physiological parameters and waves and other information of patients and provide patient information, alarm information, clock, monitor status and other tips. The figure below is the standard interface (demo mode) of the monitor in the normal monitoring state.

The screen of the standard interface is divided into four areas: ①,1Info area, ②,2Parameter area, ③,3Wave area, ④,4Info tip area, ⑤,5Smart hotkey area.

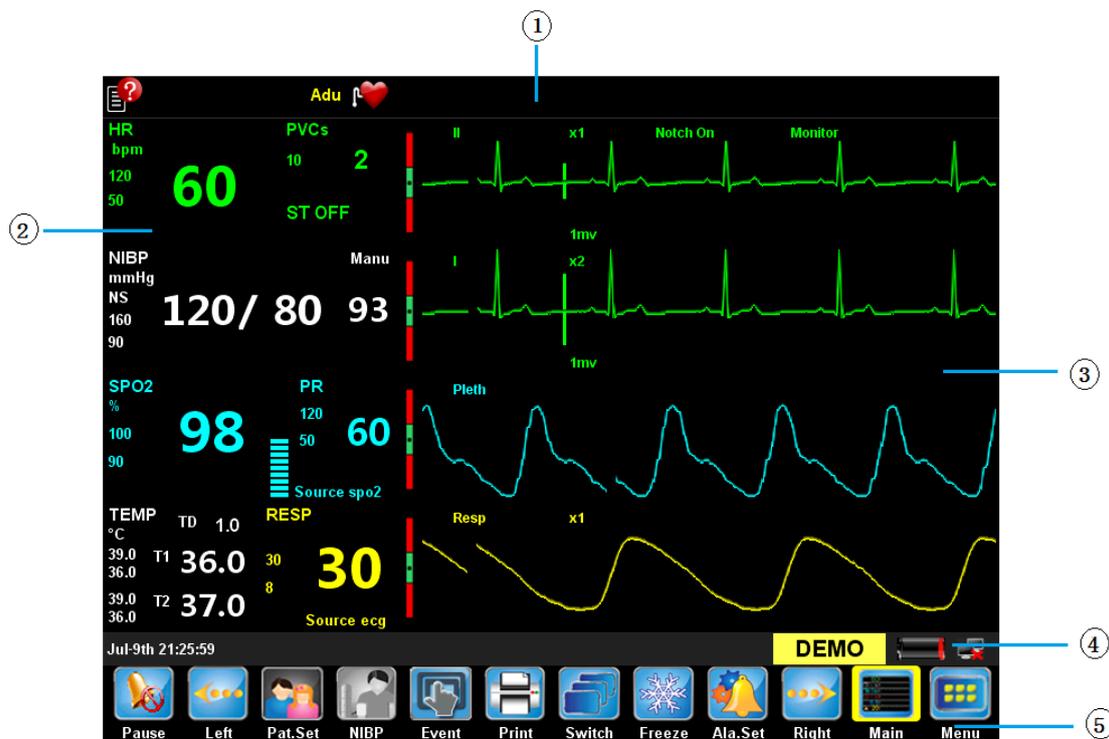


Fig. 2-4 Standard Interface (Demo Mode)

### 1. Introduction of info area (①,1)

The info area includes patient information, alarm status icon, physiological alarms and technical alarms from left to right.

### 2. Introduction of parameter area (②,2)

It consists of small parameter areas, which show the corresponding parameter measurement value and current upper and lower alarm limits of each parameter module. The parameters are shown in fixed positions, that is, from top to bottom and from left to right:

- ECG parameter area

- NIBP parameter area
  - SPO2 and PR parameter area
  - TEMP parameter area
  - RESP parameter area
3. Introduction of wave area (○,3)
- It mainly displays the waves of physiological parameters, and upper left corner of each wave shows the wave name.
4. Introduction of info tip area (○,4)
- Display the current time, freezing information, battery status, network status, etc.; in DEMO mode, it displays [DEMO].
5. Introduction of smart hotkey area (○,5)
- The smart hotkey area shows the hotkeys, which are mainly used for some common operations; see 2.4 for details.

## 2.4 Smart Hotkeys

Smart hotkeys are some graphics hotkeys displayed at the bottom of the main screen of the monitor, and enable you to use certain features conveniently.

The smart hotkeys at the bottom of the main screen are divided into fixed smart hotkeys and removable smart hotkeys.

There are five fixed smart hotkeys, of which the names or features are:



[Pause]: Alarm pause



[Left]: Slide left to show more smart hotkeys



[Right]: Slide right to show more smart hotkeys



[Main]: Return to the main interface



[Menu]: Main menu

There are ten removable smart hotkeys:



[Pat.Set]: Patient info setting key



[NIBP]: NIBP measurement start / stop key



[Event]: Manual event



[Print]: Print key



[Switch]: Interface switch key



[Freeze]: Freeze key



[Ala.Set]: Alarm setting key



[Silence]: Silence key



[Review]: Review key



[Vol.Set]: Volume setting key

# Chapter 3. Basic Operation

## 3.1 Installation

### Note

- To ensure normal working of the monitor, read this chapter before use, and install as required.



### Warning

- All analog and digital devices connected to the monitor must be certified by IEC standards (e.g., IEC 60950 Data Processing Equipment Standard and IEC 60601-1 Medical Equipment Standard). Furthermore, all configurations shall comply with valid version of IEC 60601-1 standard. The personnel connecting additional devices to the input / output signal ports are responsible for the compliance with IEC 60601-1 standard. If there is any question, please contact **manufacturer**.
- If the patient cable interface and network interface are connected with multiple devices, the total electric leakage cannot exceed the allowable value.
- The copyright of the monitor software belongs to **manufacturer**. Without permission, any organization or individual shall not interpolate, copy or exchange by any means or form.
- When the monitor is combined with other devices, it must comply with IEC60601-1, and shouldn't be connected with multi-socket wire board or extension cord.

### 3.1.1 Unpacking

Before unpacking, please check the box carefully. If any damage is found, please contact the carrier immediately. Unpack properly, take out the monitor and accessories carefully, and check the accessories according to the packing list. Check for any mechanical damage and if the items are complete. If there is any question, please contact our sales department or dealer.

### Note

- Please keep the packing box and material for use in future transporting or storage.

### 3.1.2 Environmental Requirements

The storage, transport and use of the monitor must meet the following environmental requirements.

Working environment	Ambient temperature range	5°C~40°C
	Relative humidity range	≤80%
	Atmospheric pressure range	86kPa~106kPa
Supply voltage requirement	Supply voltage	a.c.100V~240V
	Power frequency	50Hz/60Hz
	Input power	40VA-60VA
	Fuse	FUSE T 1.6A
Transportation	Prevent severe shock, vibration, rain and snow splashing during transport.	
Storage	The packaged monitor should be stored in well-ventilated room with ambient temperature -20°C ~+55°C, relative humidity lower than 93%, atmospheric pressure 50kPa~106kPa, and without corrosive gases.	

The operating environment of the monitor should avoid noise, vibration, dust, corrosive or flammable and explosive materials. In order to allow air flowing smoothly and achieve good heat dissipation, at least 2 inches (5cm) clearance should be kept around the device.

When the device is moved from one environment to another, the device may have condensation due to differences in temperature or humidity. In this case, wait until the condensation disappears before using the device.



### **Warning**

- Please ensure that the device operates under stipulated environment, or else technical specifications declared in this Manual may not be met, and it may result in damage to equipment and other unforeseen consequences.

## **3.2 Connecting to AC Power**

Connect to AC power in the following steps:

- Make sure that the AC power supply meets the following specifications: AC 100V ~ 240V, 50/60Hz.
- Use the power cord provided with the monitor. Plug the power cord into the power connector of the monitor and plug the other end of the power cord into the mains (low voltage power supply network facilities) power outlet with protective earthing.

## Note

- **Connect the power cord to the dedicated outlet in the hospital.**

## 3.3 Turning on

### 3.3.1 Checking the Monitor

- Before turning on, check whether there is mechanical damage to the monitor, and whether the external cables and accessories are connected correctly.
- Plug the power cord into the AC power outlet. If using battery power, make sure the battery is fully charged.
- Check all the functions required for patient monitoring to make sure that the monitor works properly.



### Warning

- **If the monitor is damaged, or fails to work normally, do not use it for patient monitoring. Please contact the maintenance personnel or manufacturer immediately.**

### 3.3.2 Starting the Monitor

After checking the monitor, you'll be ready to start the monitor.

Press the power switch, the yellow and red warning lights flash once in turn, and the system enters the program reading interface; then the company's LOGO is shown; finally, the system makes a “tick” sound, the boot screen disappears, and the system enters the main interface.

If the yellow and red warning lights flash once in turn when the device is turned on and the monitor makes a “tick” sound, the warning system of the monitor can work normally.

## Notes

- **If any fatal error occurs during self-test, the system will alarm.**
- **Check all available monitoring functions to ensure that the monitor functions properly.**
- **If the monitor integrates a battery, charge the battery after each use to secure sufficient power.**

### 3.3.3 Connecting the Sensor

Connect the required sensor to the monitor and the monitoring position on the patient.

#### Note

- **For proper connections and related requirements for a variety of sensors, see Chapters 7-12.**

### 3.3.4 Starting Monitoring

Start monitoring in the following steps:

- Check if the patient cable and the sensor are connected properly.
- Check if the settings of the monitor are correct, such as: patient category [Patient Cat.]
- For the details of parameter measurement or monitoring, see the appropriate section.

## 3.4 Turning off

Please turn off the monitor in the following steps:

- Disconnect the cables and sensors connected to the patient.
- Press and hold the power switch for two seconds to pop up the 5sec countdown window, and the monitor turns off in five seconds.



#### Caution

- **If the monitor cannot be turned off properly or special cases occur, you can simply disconnect the power to force shutdown. However, forced shutdown may cause data loss, and is not recommended.**

## 3.5 Basic Operation

### 3.5.1 Using the Shuttle

Shuttle can be used to perform the following operations:

- Rotate: Rotate clockwise or counterclockwise to move the focus.
- Press: Press the shuttle to perform an action, such as access to a menu or execute a command.

Shuttle is the main control key. On the interface or the menu, the green highlighted box that moves with the knob turning is called the cursor. By turning the shuttle, you can position the cursor in order to perform the desired operation.

### 3.5.2 Using Keys

The monitor has three types of keys:

- Soft keys: The position that the cursor can stay on the interface, allowing quick access to certain menus or performing certain actions, including:
  - ◆ Parameter hotkey: Select a parameter area and enter the appropriate parameter setup menu.
  - ◆ Wave hotkey: Select a wave area and enter the appropriate parameter setup menu.
  - ◆ Smart hotkey: The shortcut keys that the user can operate quickly at bottom of the screen; see “Smart Shortcuts” for details.
- Hard keys: The physical keys on the monitor, such as the alarm silence key on the front panel.
- Popup keys: Menu keys relevant to the tasks that automatically appear in the monitor screen when needed. For example: the confirmation key popped up when you need to confirm the change.

### 3.5.3 Using the Touch Screen

You can directly click on the touch screen to quickly and easily accomplish some operations.

### 3.5.4 Using Soft Keyboard

Click on the edit box, and the system will display the soft keyboard on the screen; you can turn the shuttle or use the touch screen to select characters one by one, and input data. Use the Back key to delete a single character; use the Enter key to confirm that you have finished entering and close the soft keyboard.

### 3.5.5 Using Menu

Select the  [Menu] key on the monitor interface via the shuttle or directly the touch screen to open the [Main Menu] as shown below. Through the main menu, you can complete most of

the operations and settings.



Fig. 3-1 [Main Menu]

The style of other menus is basically similar to the [Main Menu], and generally consists of the following components:

- Menu title: a summary of the current menu.
- Close menu: Close the current menu, exit the current menu or close the current menu and return to the previous menu.
- Main display area: display options, buttons or prompt messages. The symbol ">>" indicates that selecting this option can enter the corresponding submenu.
- Confirmation key area: Some menus contain a confirmation key area to confirm the menu operations, including confirmation and cancel key.

## 3.6 Operating Mode

The monitor has 2 operating modes, of which the demo mode is protected by a password.

### 1. Monitoring mode (operating mode)

This is the daily operating mode of patient monitoring; you can change some settings in accordance with the patients, such as alarm limits. However, when the patient is discharged, the monitor will restore these settings to default according to pre-set configuration.

### 2. Demo mode

This mode is protected by a password (default: 8888) for demonstration purpose only.

- Enter the demo mode:
  - ◆ Select  [Menu] Smart Hotkey→[Main Menu];
  - ◆ Select [Demo >>] → enter the password and confirm, and the monitor enters the demo mode.
- Exit demo mode:
  - ◆ Select  [Menu] Smart Hotkey→[Main Menu];
  - ◆ Select [Exit Demo >>] and the monitor exits the demo mode.

### **Warning**

- **The demo mode is mainly used to show the machine performance and for user training. In actual clinical use, the demo function is prohibited in order to avoid mistaking the displayed waves and parameters as those of the patient, thus affecting patient monitoring, and delaying diagnosis and treatment.**

## 3.7 Measurement Setup

This section only describes the general settings of measuring wave in monitor mode; for other specific settings of each parameter, please refer to the appropriate section.

Click the wave area of a parameter to enter the appropriate setup menu. The setup menu defines the specific wave setup of the parameter, such as wave gain and wave speed; you may set the waves of different parameters as needed.

## 3.8 Freezing Waves

In the patient monitoring process, you can freeze the wave on the screen, review and carefully observe the patient's condition during this time. Freeze / unfreeze the wave as follows:

Select  [Freeze] hotkey to freeze the displayed wave of the monitor.

Click  [Freeze] hotkey again to release the freezing state.

## 3.9 Other Common Setup

The common setup of the monitor is the general setup that defines how the monitor works, for example: alarm volume setting. They may affect the setup of multiple measurements or display interfaces.

### 3.9.1 Defining the Monitor

When install the monitor or change the usage occasion, the monitor should be defined as follows:

- Select  [Menu] Smart Hotkey→[Main Menu];
- Select [User Maintenance >>] →enter the password and confirm → [User Maintenance] menu;
  - ◆ Select [Device Name]: Enter device name through the soft keyboard on the screen.
  - ◆ Select [Department]: Enter the sector and department using the device through the soft keyboard on the screen.
  - ◆ Select [Bed No.]: Enter the bed number through the soft keyboard on the screen.

### 3.9.2 Language Setup

Set the monitor language in the following steps:

- Select  [Menu] Smart Hotkey→[Main Menu];
- Select [User Maintenance >>] →enter the password and confirm → [User Maintenance] menu;
- Select [Language], and select the option as needed:
  - ◆ [English]: The interface language of the monitor is English.
  - ◆ [Spanish]: The interface language of the monitor is Spanish.

### 3.9.3 Date and Time

Set the monitor time in the following steps:

- Select  [Menu] Smart Hotkey→[Main Menu];
- Select [Time Setup >>] → enter [Time Setup] menu;

- Select [Date Format], and set the date format in accordance with custom
  - ◆ [YYYY-MM-DD]: Year - Month - Day.
  - ◆ [MM-DD-YYYY]: Month - Day - Year.
  - ◆ [DD-MM-YYYY]: Day - Month - Year.
- [Date]: Set the year, month, and day.
- [Time]: Set the hour, minute and second.

### 3.9.4 Volume Control

#### 1. Alarm volume

- Select  Vol.Set smart hotkey → [Volume Setup] menu;
- Select [Alarm Vol]: Set [Y]. Y is X~9, X is the minimum volume, and Y value plus / minus 1 when turning the shuttle once.

#### 2. Key-pressing volume

- Select  Vol.Set smart hotkey → [Volume Setup] menu;
- Select [Key Volume]: [N]. N value ranges from 0 to 9, plus / minus 1 when turning the shuttle once, select 0 to turn off the key-pressing tone, and select 9 to set to the maximum volume.

#### 3. QRS volume

Select  Vol.Set smart hotkey → [Volume Setup] menu;

Select [QRS Volume]: [M]. M values ranges from 0 to 9, plus / minus 1 when turning the shuttle once, select 0 to turn off the key-pressing tone, and select 9 to set to the maximum volume.

### 3.9.5 Changing Password

To access to the User Maintenance menu, you need to enter the password (default: 1211); to change the password, operate as follows:

- Select  [Menu] Smart Hotkey→[Main Menu];
- Select [User Maintenance >>] →enter the password and confirm → [User Maintenance] menu;
- Select [Modify password >>] → enter [Modify Password] menu;
  - ◆ Select [Old Password]: Enter the current password.

- ◆ Select [New Password]: Enter the new password.
- ◆ Select [New Password]: Enter the new password again.
- ◆ Select [Ok] to save the new password.

### 3.9.6 Setting Parameter Unit

You can select a preferred unit through the following operations

- Select  [Menu] Smart Hotkey → [Main Menu];
- Select [User Maintenance >>] → enter the password and confirm → [User Maintenance] menu;
- Select [Unit Setup >>] → [Unit Setup] menu;
  - ◆ Select [Height], and select the unit [cm] / [inch] as needed.
  - ◆ Select [Weight Unit], and select the unit [kg] / [lb] as needed.
  - ◆ Select [Press.Unit], and select the unit [mmHg] / [kPa] as needed.
  - ◆ Select [Temp Unit], and select the unit [°C] / [°F] as needed.

# Chapter 4. Patient Information Management

Connect the patient to the monitor, and the monitor will display and store the physiological data of the patient, so the patient can be monitored without admitting the patient. However, admitting the patient correctly is very important.

If the monitor has admitted the patient, it is recommended to operate the monitor to discharge the current patient before connecting to (not admitted) the next patient. Otherwise, the data of the previous patient will be stored in the data of the current patient.



## Warning

- **Whether the patient is admitted or not, the system will give a default value to [Patient Cat.] and [Paced], and the user must confirm that the default value is appropriate for the patient being monitored.**
- **For patients with pacemakers, [Paced] must be set to [Yes]. Otherwise, the pacing pulse will be treated as normal QRS wave group, and the system is unable to detect the alarm status of [ECG Signal weak].**
- **For patients without a pacemaker, [Paced] must be set to [No]. Otherwise, the system is unable to detect the arrhythmias (including PVCs count) related to ventricular premature beats, and fails to perform ST segment analysis.**

## 4.1 Patient Setup Menu

You can manage the patients through the [Patient Setup] menu ; to enter the [Patient Setup] menu, operate as follows:

Select  [Menu] Smart Hotkey → [Main Menu];

Select [Patient Setup >>] → [Patient Setup] menu, as shown in Fig. 4-1.

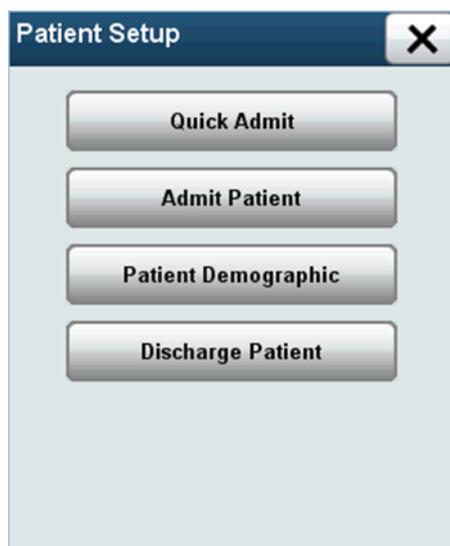


Fig. 4-1 Patient Info Setting

## 4.2 Admitting a Patient Quickly

Admit a patient quickly as follows:

In [Patient Setup] menu, select [Quick Admit] → [Warning] menu → [OK] → [Quick Admit] menu, which is shown below:

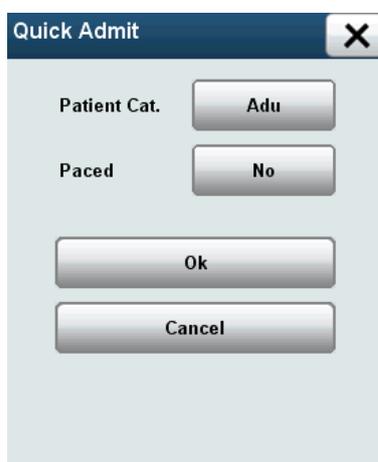


Fig. 4-2 Quick Admitting Menu

- Select [Patient Cat.], and set the patient category as needed:
  - ◆ [Adu]: Adults.
  - ◆ [Ped]: Pediatric.
  - ◆ [Neo]: Neonatal

- Select [Paced], and set whether the patient wears a pacemaker according to the patient condition:
  - ◆ [Yes]: The patient wears a cardiac pacemaker.
  - ◆ [No]: The patient does not wear a cardiac pacemaker.

After setting, select [OK] to save the current setup; select [Cancel] and do not save the current setup.

## 4.3 Admitting a Patient

To admit a patient, operate as follows:

In the [Patient Setup] menu, select [Admit Patient] → [Warning] → [OK] → [Patient Info] menu, which is shown below:

SurName	<input type="text"/>		
Name	<input type="text"/>		
Case	<input type="text"/>		
Gender	<input type="button" value=""/>	Height (cm)	<input type="text"/>
Patient Cat.	<input type="button" value="Adu"/>	Weight (kg)	<input type="text"/>
Paced	<input type="button" value="No"/>	Blood Type	<input type="text"/>
Admit date (yyyymmdd)	<input type="text"/>	-	<input type="text"/>
Birthday (yyyymmdd)	<input type="text"/>	-	<input type="text"/>
<input type="button" value="Ok"/>		<input type="button" value="Cancel"/>	

Fig. 43 Patient Info

1. Select [SurName], and enter patient's surname through the soft keyboard.
2. Select [Name], and enter patient name through the soft keyboard.
3. Select [Case], and enter the case number through the soft keyboard.
4. Select [Gender], and set the patient's gender according to the patient condition:

- ◆ [Male]: Males.
  - ◆ [Female]: Females.
  - ◆ [Others]: Others.
5. Select [Patient Cat.], and set the patient category as needed:
    - ◆ [Adu]: Adults.
    - ◆ [Ped]: Pediatric.
    - ◆ [Neo]: Neonatal.
  6. Select [Paced], and set whether the patient wears a pacemaker according to the patient condition:
    - ◆ [Yes]: The patient wears a cardiac pacemaker.
    - ◆ [No]: The patient does not wear a cardiac pacemaker.
  7. Select [High (cm)], and set the patient's height via the pop-up keyboard on the screen.
  8. Select [Weight (kg)], and set the patient's weight via the pop-up keyboard on the screen.
  9. Select [Blood Type], and set the patient's blood type:
    - ◆ [A]: Patient blood type is A.
    - ◆ [B]: Patient blood type is B.
    - ◆ [AB]: Patient blood type is AB.
    - ◆ [O]: Patient blood type is O.
    - ◆ [Others]: Other blood type of the patient.
  10. Select [Admit date (yyyy-mm-dd)], and set the date of admitting the patient.
  11. Select [Birthday (yyyy-mm-dd)], and set the birth date of the patient.

After setting, select [OK] to save the current setup; select [Cancel] and do not save the current setup.

## 4.4 Editing Patient Info

When the monitor has admitted a patient, but the patient information is incomplete, or needs to be changed:

Select the patient info area on the display to pop up [Patient Info] menu as shown in Fig. 4-3, and complement or change the patient info in the [Patient Info] menu; see 4.2 for specific operation.

## 4.5 Discharging a Patient

To discharge a patient, operate as follows:

In the [Patient Setup] menu, select [Discharge Patient] → [Warning] → [OK] to finish the operation of discharging a patient.

After the patient is discharged, all the information of the patient stored by the monitor will be cleared. Therefore, discharge the patient only when needed.

# Chapter 5. User Interface

The monitor has four working interfaces, which are “Normal Screen”, “Big Numerics”, “ECG 7-Lead Half-Screen” and “ECG 7-Lead Full-Screen”. The user can select the working interface according to needs, and get different screen information. Below describes the working interfaces.

## 5.1 Selecting User Interface

Select the user interface as follows:

- Select  [Switch] smart hotkey→[Screen Setup];
- Select [Screen Select], and select the user interface according to needs:
  - ◆ [Normal Screen]: Standard interface.
  - ◆ [Big Numerics]: Big font interface.
  - ◆ [ECG 7-Lead Half-Screen]: ECG 7-lead half-screen.
  - ◆ [ECG 7-Lead Full-Screen]: ECG 7-lead full screen.

## 5.2 Interface Introduction

### 5.2.1 Normal Screen

The normal screen is as shown in Fig. 5-1:

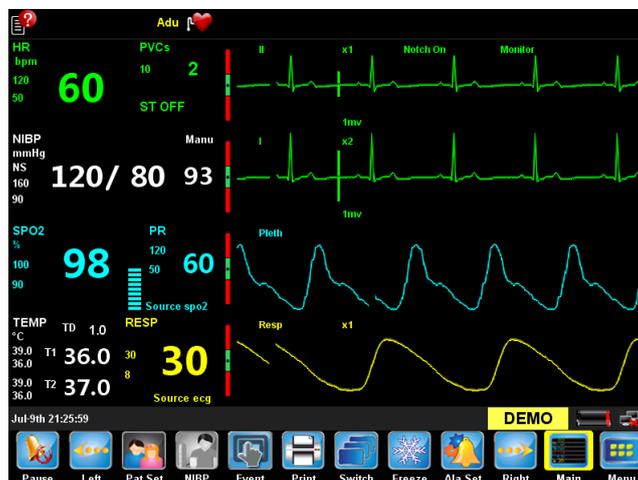


Fig. 5-1 Normal Screen

The normal screen provides the parameter wave being monitored and the parameters displayed in the parameter area. This is the basic working interface of the monitor. The interface displays all parameters, two ECG waves, one blood oxygen binding capacity scan wave, and one respiratory wave.

### 5.2.2 Big Numerics

The Big Numerics screen is as shown in Fig. 5-2:

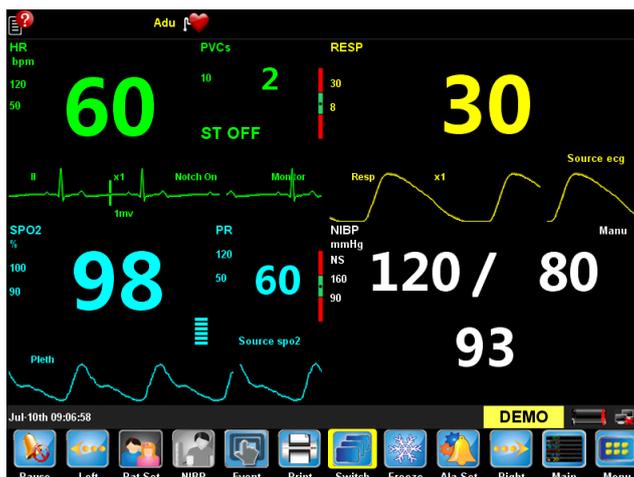


Fig. 5-2 Big Numerics Screen

Big Numerics screen allows observing other parameters except the body temperature, one ECG wave, one respiratory wave, and one blood oxygen binding capacity scan wave.

### 5.2.3 ECG 7-Lead Half-Screen

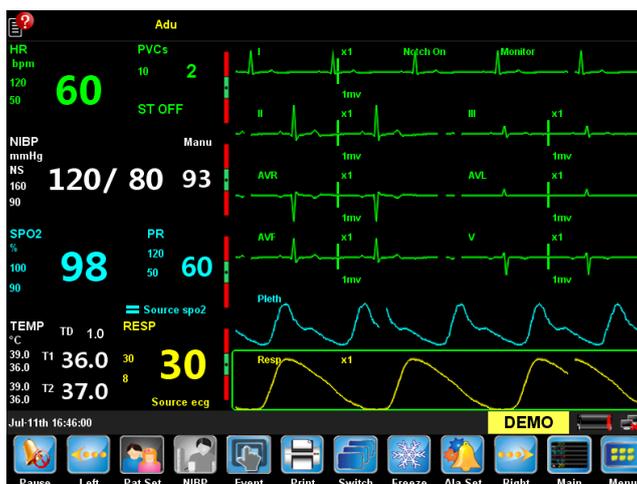


Fig. 5-3 ECG 7-Lead Half-Screen

ECG 7-Lead Half-Screen allows observing all parameters, seven ECG waves (I, II, III, AVR, AVL, AVF, V), one blood oxygen binding capacity scan wave, and one respiratory wave.

## 5.2.4 ECG 7-Lead Full-Screen

ECG 7-Lead Full-Screen is shown below:

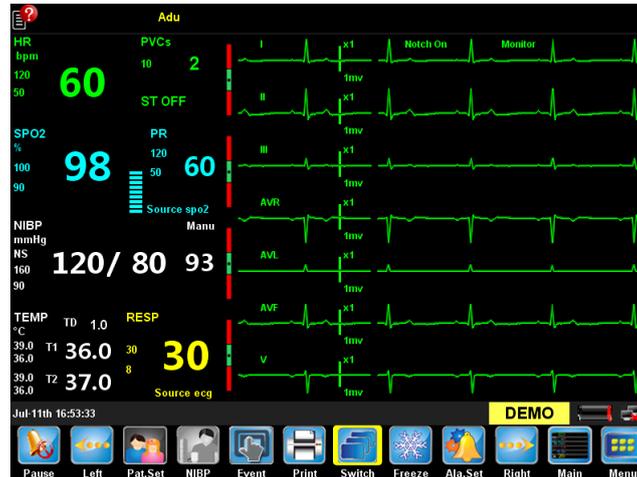


Fig. 5-4 ECG 7-Lead Full-Screen

This interface allows observing all parameters, and seven ECG waves (I, II, III, AVR, AVL, AVF, V) simultaneously.

# Chapter 6. Alarm

Alarm means that the monitor prompts the medical staff through sound and light when the patient being monitored has abnormal changes in vital signs or the monitor has a failure and is unable to monitor the patient successfully.



## Warning

- In any single region (e.g. ICU), it has potential dangers if the same or similar devices use different alarm setups.

## Note

- After setting, the alarm and other parameters of the monitor won't be lost when the system power is cut off, unless modified manually; connect the power again (external and internal) and turn on the monitor, it will resume normal working, and the alarm and other parameters remain unchanged.

## 6.1 Alarm Type

According to the nature of the alarm, the alarms of the monitor can be divided into physiological alarms, technical alarms and prompt messages.

### ■ Physiological alarms

A physiological alarm is usually triggered when a physiological parameter of the patient exceeds the alarm limit or the patient has physiological abnormalities. The information of physiological alarm is displayed in the physiological alarm area on top of the screen.

### ■ Technical alarms

Technical alarm is also known as a system error message, which is caused by improper operation or system failure resulting in system malfunction or monitoring result distorted. The information of technical alarm is displayed in the technical alarm area on top of the screen.

### ■ Prompt messages

Strictly speaking, the prompt messages are not alarms. The monitor also will display some information associated with system status in addition to the physiological alarms and technical alarms, and generally such information do not involve the patient's vital signs. The prompt messages generally appear in the technical alarm area and parameters area.

## 6.2 Alarm Level

According to the severity of the alarm, the physiological alarms of the monitor can be divided into high level, medium level and low level.

### ■ High level alarms

The patient is in critical condition that is life-threatening, and should be immediately rescued;

Or the monitor has a serious mechanical failure or malfunction, causing it unable to detect the patient's critical state and endangering the patient's life.

### ■ Medium level alarms

The patient's physiological signs are abnormal, and appropriate measures or treatment should be taken immediately;

Or although it won't endanger the patient's life, the mechanical failure or misoperation of the monitor will affect the normal monitoring of key physiological parameters.

### ■ Low level alarms

The patient's physiological signs are abnormal, and appropriate measures or treatment may need to be taken;

Or certain monitoring function is invalid due to mechanical failure or misoperation, but it won't endanger the patient's life.

The levels of all technical alarms and some physiological alarms have been set in the monitor at the factory and cannot be modified by the user. The levels of some physiological alarms can be modified.

## 6.3 Alarm Mode

When an alarm occurs, the monitor uses the following audible or visual alarm to prompt the user:

- Light alarm
- Audible alarm
- Alarm info
- Parameter flashing

Of which, the light alarm, audible alarm, and alarm info distinguish the alarm levels in a different manner respectively.

### 6.3.1 Light Alarm

When an alarm occurs, the alarm indicator will flash in different colors and frequencies to prompt the alarm level.

- High level alarm: Red, fast flashes
- Medium level alarm: Yellow, slow flashes
- Low level alarm: Yellow, lit without flashing

### 6.3.2 Audible Alarm

An audible alarm is that the monitor prompts the alarm levels with different sound characteristics when an alarm occurs.

- High level alarm: Beep - beep - beep -- beep - beep ---- beep - beep - beep -- beep - beep
- Medium level alarm: Beep - beep - beep
- Low level alarm: Beep

### 6.3.3 Alarm Info

Alarm info refers to that the physiological or technical alarm area of the monitor will display the corresponding alarm information when an alarm occurs. The system will distinguish the alarm levels with different background colors:

- High level alarm: Red
- Medium level alarm: Yellow
- Low level alarm: Yellow

The following flags in front of physiological alarms are used to distinguish the alarm levels:

- High level alarm: \*\*\*
- Medium level alarm: \*\*
- Low level alarm: \*

### 6.3.4 Parameter Flashing

When a physiological parameter of the patient alarms, the parameter values in the parameter area will flash once per second, and the upper limit and lower limit of the parameter will also

flash at the same frequency, indicating that the parameter exceeds the upper limit or lower limit.

## 6.4 Alarm States

In addition to the above alarm modes, you can also set the monitor to the following four alarm states as needed, and display different alarm icons on the screen:

-  Alarm silence
-  Alarm sound off
-  Alarm pause
-  Alarm off

### 6.4.1 Silence

Select  [Silence] smart hotkey, and you can temporarily turn off the alarm sound of currently occurring physiological alarms of the monitor, but the alarm information is still retained. For technical alarms, clear the alarm state, display alarm prompt information only and the monitor enters alarm silence state, and the alarm state icon area displays the  icon. When a new physiological alarm or technical alarm occurs, the alarm silence is automatically canceled.

### 6.4.2 Alarm sound off

The alarm sound can be turned off through the following operations:

- Select  [Menu] Smart Hotkey → [Main Menu];
- Select [User Maintenance >>] → enter the password and confirm → [User Maintenance] menu;
- Select [Alarm Param >>] → [Ala.Para Setup] menu;
- Set [Min Alarm Vol] to [0];
- Select  [Vol.Set] smart hotkey → [Volume Setup] menu;
- Set [Alarm Volume] to [0].

When the alarm sound is turned off, the alarm state area on the screen shows the  icon.

If [Min Alarm Vol] is larger than 0, the system will cancel alarm sound off state.

### 6.4.3 Alarm Pause

Press the  [Pause] smart hotkey to temporarily stop the alarm of the monitor in the following steps:

- Alarm state icon area will display the  icon.
- The light alarm and audible alarm of the physiological alarms are suspended, and the alarm information is not displayed.
- The remaining time of alarm pause is displayed in the physiological alarm area.
- Alarm parameters and upper / lower limit stop flashing.
- The audible alarm and light alarm of technical alarms are suspended, but the alarm message is still displayed.

After the alarm pause is finished, the monitor will automatically cancel the alarm pause state. During the alarm pause, you can also press  [Pause] smart hotkey to manually cancel the alarm pause.

You can set the alarm pause time as follows:

- Select  [Menu] Smart Hotkey → [Main Menu];
- Select [User Maintenance >>] → enter the password and confirm → [User Maintenance] menu;
- Select [Alarm Param >>] → [Ala.Para Setup] menu;
- Select [Alarm Pause Time], and set the alarm pause time as needed:
  - ◆ [1min] / [2min] / [3min] / [4min] / [5min] / [10min] / [15min]: Set the alarm pause time to 1 min, 2 min, 3 min, 4 min, 5 min, 10 min or 15 min. By default, the alarm pause time is 2 minutes.
  - ◆ [Permanent]: Set the alarm pause time to permanent.

### 6.4.4 Alarm off

As shown in 6.4.3, if the [Alarm Pause Time] is set to [Permanent], press the  [Pause] smart hotkey, and the monitor will turn off the alarm. In this case, except the alarm prompt characteristics maintained in alarm pause state:

- Alarm state icon area will display the  icon.

- The physiological alarm area displays [Alarm Pause].

You can press the  [Pause] smart hotkey again to manually cancel the alarm off.

If the monitor is in the alarm state of suspension or closure of senior technical alarm is triggered, the alarm and the alarm off pause are automatically canceled.



## Warning

- **When the alarm volume is set to 0 or the alarm pause time is set to permanent, the monitor does not sound an alarm when an alarm occurs. Therefore, the operator should use this feature carefully.**

## 6.5 Alarm Setup

### 6.5.1 Setting the Alarm Sound

See 3.9.4 Volume Control for the method to set the alarm volume.

### 6.5.2 Setting the Alarm Delay Time

For over-limit alarm of continuous measurement parameter, you can set the alarm delay time. If the alarm condition disappears during the delay period, the monitor won't alarm. In [Ala.Param Setup] menu, select [Alarm Delay] time and [ST Alarm Delay] time.

The specific operation is as follows:

- Select  [Menu] Smart Hotkey→[Main Menu];
- Select [User Maintenance >>] →enter the password and confirm → [User Maintenance] menu;
- Select [Alarm Param >>] → [Ala.Param Setup] menu;
- Select [Alarm Delay], and set the alarm delay time as needed:
  - ◆ [Off]: Turn off the alarm delay.
  - ◆ [1s] / [2s] / [3s] / [4s] / [5s] / [6s] / [7s] / [8s]: Alarm delay time is 1 sec, 2 sec, 3 sec, 4 sec, 5 sec, 6 sec, 7 sec or 8 sec. By default, the alarm delay time is 4 seconds.
- Select [ST Alarm Delay], and set the ST alarm delay time as needed
  - ◆ [Off]: ST alarm delay is off
  - ◆ [10s] / [20s] / [30s] / [45s] / [1min] / [2min] / [3min]: ST alarm delay time is 10 sec, 20 sec, 30 sec, 45 sec, 1 min, 2 min or 3 min. By default, the ST alarm delay time is 20 seconds.

The system sets physiological alarm delay time and also sets 1~2s delay time after technical alarm been triggered. Normally the delay time is limited to 5s.

### 6.5.3 Setting a Parameter Alarm

With SpO2 for example, select the SpO2 parameter area, select [Alarm Setup >>] in the popup [SpO2 Setup] menu to enter the SpO2 alarm setup interface.

1. Turn on / off alarm

- Select [Alarm Switch] and set the alarm switch as follows:

- ◆ [On]: Turn on SpO2 alarm; when the parameter alarm occurs, the monitor will prompt according to the set alarm level.
- ◆ [OFF]: Turn off SpO2 alarm;  icon is displayed in the parameter area, and the monitor won't prompt the parameter alarm.

2. Set the alarm level

- Select [Alarm Level], and set the alarm level as follows:

- ◆ [Low]: Set the alarm level to low.
- ◆ [Mid]: Set the alarm level to medium.
- ◆ [High]: Set the alarm level to high.

3. Set the alarm limit

In any cases, the alarm system only allows setting the values within the effective range of the system, and the upper alarm limit must be higher than the lower alarm limit.

- Select [Spo2 Low Limit] and set the lower limit of SpO2 alarm.
- Select [Spo2 High Limit] and set the upper limit of SpO2 alarm.

4. Restore default alarm setup

- Select [Default] and restore the alarm setup to the factory default.

### Note

- **When setting the upper and lower alarm limit, confirm the patient category to be adults or pediatric, and set its scope according to the clinical need. If the setting exceeds the alarm limit, the alarm system will fail easily.**
- **When the alarm limit is turned on, and the upper and lower alarm limits are manually set, the instrument will display the upper and lower alarm limits continuously, and the initial alarm preset value won't be provided additionally.**

## 6.6 Latch Alarm

Physiological alarms can be set to [Latching] or [No latching].

- [Latching]: Even if the cause of physiological alarm is cleared, the system will still be “latched”, that is, continue to display the alarm information corresponding to physiological alarm, the alarm sound also continues, but the alarm mode has the following changes:
  - ◆ Parameters and upper or lower alarm limit are no longer flashing.
  - ◆ Display the time that the latest alarm was triggered after the alarm message in the physiological alarm area.
- [No latching]: After the causes of physiological alarm are cleared, the system will no longer prompt the physiological alarm.

The default alarm of the system is non-latching alarm; you can set the alarm as latching or non-latching in the following steps:

- Select  [Menu] Smart Hotkey→[Main Menu];
- Select [User Maintenance >>] →enter the password and confirm → [User Maintenance] menu;
- Select [Alarm Param >>] → [Ala.Param Setup] menu;
- Select [Latching Alarms], and set the alarm as needed:
  - ◆ [Latching]: Latching alarm.
  - ◆ [No latching]: Non-latching alarm.

## 6.7 Manual Event

In the patient monitoring process, some events may have an impact on the patient, resulting in changes of some monitoring waves or parameters. In order to assist in the analysis of these effects, you can manually record these events through the  [Event] smart hotkey, and then view it in the event review; refer to 13.4 Event Review for detailed operation.

# Chapter 7. ECG

## 7.1 Overview

Electrocardiogram (ECG) is produced by the continuous electrical activity of the patient's heart and displayed with waves and numerics on the monitor in order to accurately assess the physiological state of the patient at the time. The ECG cable should be connected properly, so as to obtain a correct measurement value and normal display. This monitor can simultaneously display 7 ECG waves.

Patient cable consists of two parts:

- Wires connected to the monitor
- ECG device connected to the patient

Connect to the monitor with five lead ECG cable, and ECG can display two different waves by adjusting the two leads. You can use the shuttle to change the lead name on the left of the ECG wave on the screen and select the lead to be monitored.

The parameters displayed in the parameter area of the monitor include heart rate (HR), ST segment measurements and arrhythmia counts per minute.

All these parameters can be used as alarm parameters.

### Note

- **In the factory setup of this instrument, ECG waves display in the first two waves from the top in the wave area in the normal screen.**

## 7.2 Safety Information



### Warning

- **To monitor ECG signal with this monitor, ECG cable and ECG electrodes specified in the Operator's Manual must be used.**
- **When you connect electrodes or patient cable, make sure that the patient is absolutely not connected with any other conductive parts or in contact with the ground. In particular, make sure that all the ECG electrodes, including the neutral electrodes, are attached to the patient and prevent them from contact with the conductive parts or ground.**

- **Periodically check the skin that the electrode is placed at; if there is any sign of allergy, replace the electrode or change the placement position.**
- **Electrosurgery (ESU) device interference, defibrillator discharge:**
  - ◇ **When the patient needs defibrillation, do not use non-defibrillator type ECG cables.**
  - ◇ **During defibrillation, the operating personnel shall not touch the patient, tables and instrument.**
  - ◇ **During defibrillation, the ECG cable connected with the patient's body may be damaged. Check if the function is normal again before using these cables.**
  - ◇ **Recover within 10 seconds after defibrillation and will not lose any stored data. During electrosurgery (ESU) or defibrillation, the measurement accuracy may be temporarily reduced. This does not affect the safety of the patient or the instrument.**
  - ◇ **Do not expose this equipment to X-ray or strong magnetic fields (MRI).**

## 7.3 Monitoring Steps

### 7.3.1 Preparation

Before placing the electrode, prepare the patient's skin in the following steps:

- **Skin preparation:** Since the skin is a poor conductor, it is very important to treat the patient's skin for electrode placement appropriately to make good contact between the electrode and the skin. Select the flat position with less muscles for the electrode placement, and refer to the method below for treatment of the skin:
  - ◆ Remove the body hair at the position for electrode placement.
  - ◆ Gently rub the skin at the position for electrode placement to remove dead skin cells.
  - ◆ Wash the skin thoroughly with soap and water (do not use ether and pure alcohol, as this will increase the skin's impedance).
  - ◆ Dry the skin completely before placing the electrode.
- Install the spring clip or stud prior to the placement of the electrodes.
- Place the electrode on the patient.
- Connect the ECG cable and ECG interface.



#### **Warning**

- **Check if the lead is normal before monitoring. When the ECG cable is unplugged, the screen will display [ECG Lead Off] prompt and trigger an audible and visual alarm.**

### 7.3.2 Selecting Lead

- Select the ECG parameter area or wave area → [ECGSetup] menu;
- Select [Other Setup >>] → [ECG Other Setup] menu;
- Select [Lead Type], and select the ECG lead as needed:
  - ◆ [3-Lead]: 3-lead; ECG wave options: I, II, III.
  - ◆ [5-Lead]: 5-lead; ECG wave options: I, II, III, AVR, AVL, AVF, V.

### 7.3.3 Lead Name and Corresponding Color

The lead names in European standard and U.S. standard (represented with R, L, N, F, C in European Standard, and represented with RA, LA, RL, LL, V in the U.S. standard) are shown in Table 7 -1.

Table 7-1: Lead Name in European Standard and American Standard

European Standard (IEC)		American Standard (AHA)	
Lead Name	Color	Lead Name	Color
R	Red	RA	White
L	Yellow	LA	Black
F	Green	LL	Red
N	Black	RL	Green
C	White	V	Brown

### 7.3.4 Installing Electrodes

- 3-lead

The electrode placement position of 3-lead is shown in Fig. 7-1:

- ◆ R electrode: placed below the clavicle, near the right shoulder.
- ◆ L electrode: placed below the clavicle, near the left shoulder.
- ◆ F electrode: placed on the left abdomen.

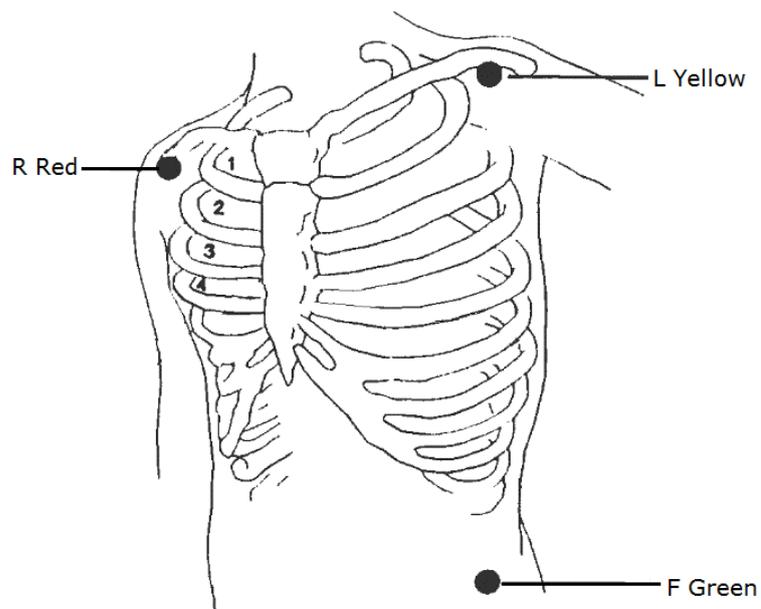


Fig. 7-1 3-lead Connection Method

■ 5-lead

The electrode placement position of 5-lead is shown in Fig. 7-2:

- ◆ R electrode: placed below the clavicle, near the right shoulder.
- ◆ L electrode: placed below the clavicle, near the left shoulder.
- ◆ n electrode: placed on the right abdomen.
- ◆ F electrode: placed on the left abdomen.
- ◆ C electrode: placed on the chest wall.

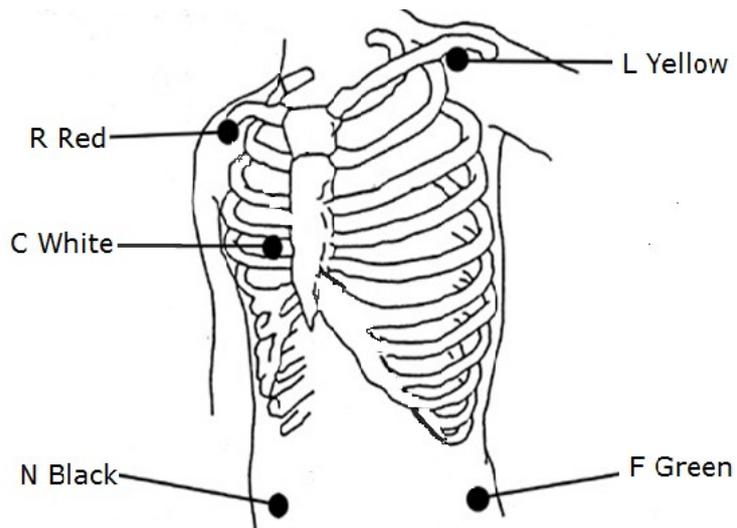


Fig. 7-2 European 5-lead Connection Method

## Notes

- To ensure patient safety, all leads must be connected to the patient.
  - If the electrodes are attached correctly, but the ECG wave is not accurate, then replace the lead.
  - Interference from ungrounded instrument near the patient and ESU interference may cause wave problems.
- 
- For 5-lead configuration, place the chest (V) lead electrode in one of these locations (see Fig. 7-3):
    - ◆ V1 is in the fourth intercostals on the right edge of the sternum.
    - ◆ V2 is in the fourth intercostals on the left edge of the sternum.
    - ◆ V3 is in the middle position of V2 and V4.
    - ◆ V4 is in the fifth intercostals of the left mid-clavicular line.
    - ◆ V5 is in the left anterior axillary line, at the same level of V4.
    - ◆ V6 is in the left axillary midline, at the same level of V4.
    - ◆ V3R-V7R is in the right chest wall, corresponding to the position of the left side.
    - ◆ VE is located on the xiphoid process. For the “V” lead placement on the back, place the “V” electrode in one of the following locations.
      - ◆ V7 is in the fifth intercostals of the left posterior axillary line on the back.
      - ◆ V7R is in the fifth intercostals of the right posterior axillary line on the back.

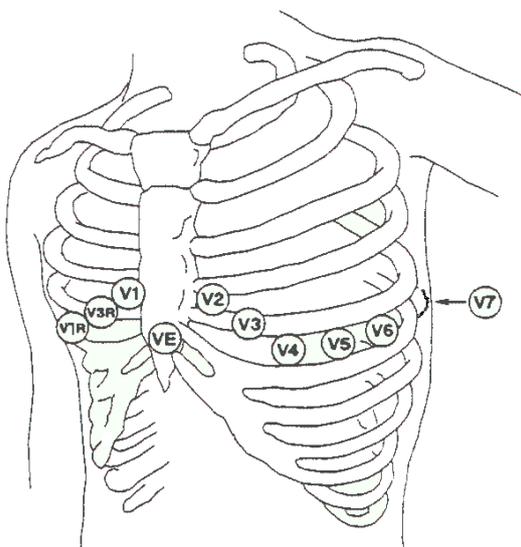


Fig. 7-3 Chest Lead Electrode Placement Position for 5-lead

### 7.3.5 Checking the Pacemaking Status

Before ECG monitoring, it is very important to set the pacemaking state of the patient properly.

If the patient has a pacemaker, set [Paced] to [Yes], and the icon  displays in the patient information area. When the system detects a pacing signal, the “|” symbol will be marked in the top of the ECG wave.

You can change the pacing state in the following method:

- Select the patient information area to pop up the [Patient Info] menu;
- Select [Yes] / [No] for [Paced] as needed, indicating that the patient with or without pacemaker

## 7.4 ECG Display

- ECG wave display

The monitor displays two ECG waves on the normal screen. Fig. 7-4 below is the monitoring interface of 5-lead, and is for reference purposes only. The graphics displayed on your monitor may be slightly different.

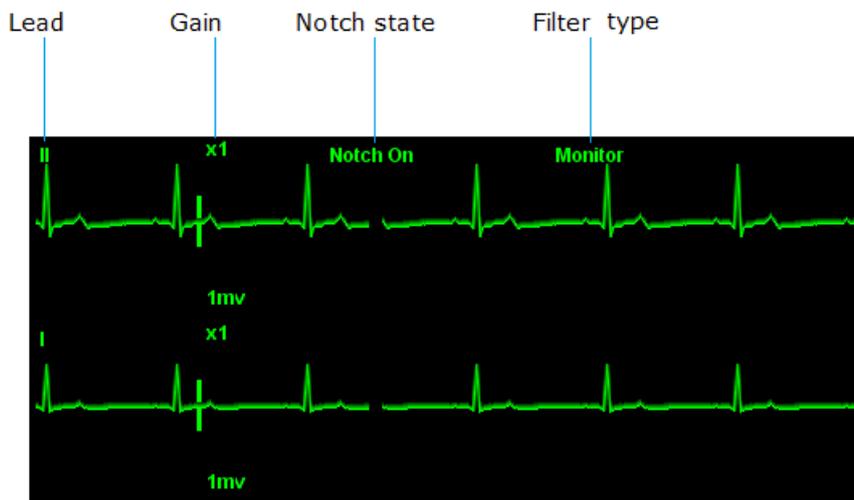


Fig. 7-4 ECG Wave on Normal Screen

In addition, when [Paced] is set to [Yes], and the patient wears a pacemaker, the “|” symbol will be marked in the top of the ECG wave.

- ECG parameter display

The ECG parameter area of the monitor in the normal screen is shown in Fig. 7-5:

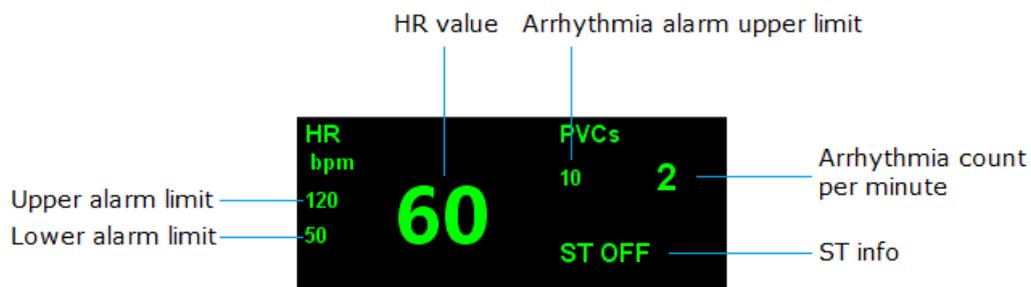


Fig. 7-5 ECG Parameter in Normal Screen

## 7.5 ECG Setup

Click the ECG parameter area or wave ECG area to pop up the [ECG Setup] menu, which is as shown below. You can set the ECG through the [ECG Setup] menu.

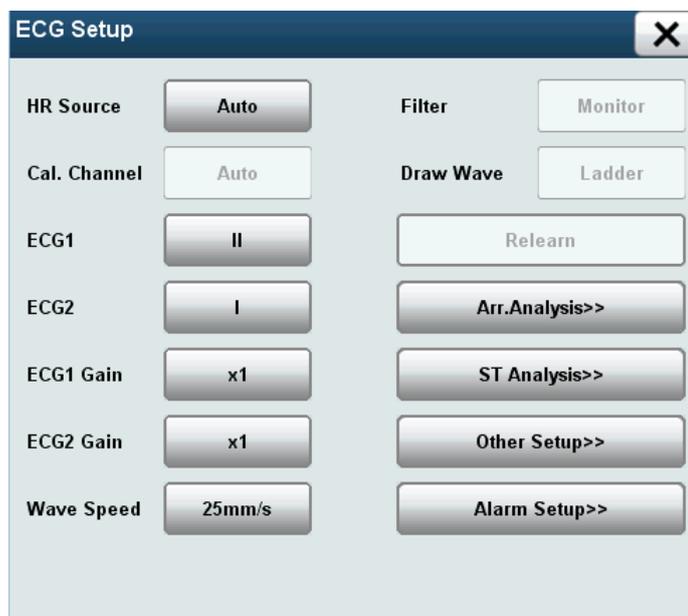


Fig. 7-6 [ECG Setup] Menu

- Select [HR Source], and set the heart rate source:
  - ◆ [Auto]: Automatically select HR source.
  - ◆ [ECG]: Select ECG monitoring as the HR source.
  - ◆ [SPO2]: Select SpO2 monitoring as the HR source.
- Select [Cal.Channel] and select heart rate calculation channel.

Select [ECG1] / [ECG2] to set the display wave channel. Select ECG1/ECG2, and set the names of upper ECG wave and lower ECG wave on the screen.

- ECG1/ECG2 should not be the source of the same wave.

- Select [ECG1 Gain] / [ECG2 Gain] and set the ECG wave gain. When the wave is shorter, increase the wave gain factor appropriately; when the wave is high or the peak cannot be displayed, reduce the wave gain appropriately.
- Select [Wave Speed], and set the wave speed.
- Select [Filter], and set the filter mode:
  - ◆ [Monitor]: Monitor mode
  - ◆ [Diagnostic]: Diagnostic mode
  - ◆ [Surgery]: Surgery mode
  - ◆ [Strong]: Strong filter mode
- Select [Draw Wave], and set the wave drawing method as below:
  - ◆ [Smooth]: Smooth
  - ◆ [Ladder]: Ladder; default.
- Select [Relearn] to learn arrhythmia. In the following cases, you need to start arrhythmia self-learning:
  - ◆ In ECG monitoring process, when the patient's ECG module has larger changes, arrhythmia self-learning should be started once.
  - ◆ ECG module changes could cause wrong arrhythmia alarm, ST measurement lost, and inaccurate heart rate.

## 7.6 Alarm Setup

Select [Alarm Setup >>] → [Alarm Setup] interface to set ECG related alarms; see 6.5 Alarm Setup for the setting method.

# Chapter 8. Resp

## 8.1 Overview

Thoracic electrical bioimpedance is a method used for measuring the respiration. When the patient is breathing, the thoracic impedance between two ECG electrodes changes due to thoracic activity. The monitor generates a respiratory wave on the screen by measuring the changing impedance value. The monitor calculates the respiration rate (RR) according to the wave cycle.

## 8.2 Safety Information

### Note

- **Respiration monitoring does not apply to patients with large range of activities, as this may lead to false alarms.**



### Warning

- **Do not use anti-electric knife ECG cable for respiration monitoring.**
- **Respiration measurement cannot identify the apnea because it will alarm if the next respiration is not detected in the predetermined period after last respiration, and therefore it cannot be used for diagnostic purpose.**

## 8.3 Placing Electrodes for Respiration Monitoring

Since the skin is a poor conductor, it is very important to treat the patient's skin for electrode placement appropriately to get better respiration signals. Refer to 7.3.1.

Respiration measurement uses standard ECG cable and electrode placement method. You can use different ECG cables (3-lead, 5-lead). Respiratory signal is measured between two ECG electrodes. If standard ECG electrode position is used, the two electrodes are R (right arm) and L (left arm) electrodes of I lead or R (right arm) and F (left leg) electrode of II lead.

## Note

- For optimal respiration wave, R and L electrodes should be placed horizontally if I lead is selected for respiration measurement; R and F electrodes should be placed diagonally if II lead is selected for respiration measurement.

Fig. 8-1 below shows the placement of 5-lead electrodes

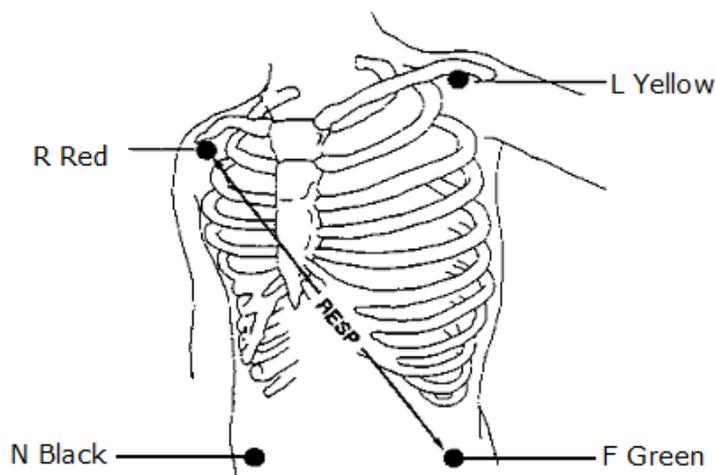


Fig. 8-1 5-lead Respiration Electrode Placement

### 8.3.1 Adjusting Position of Respiration Electrode

If you want to measure ECG and respiration simultaneously, you may need to adjust the position of the two electrodes for respiration measurement. Adjusting the standard position of ECG electrodes will lead to changes in the ECG wave, and may affect the ST and arrhythmia analysis.

### 8.3.2 Cardiomotility Superimposing

The effect of cardiomotility on the respiratory wave is called cardiomotility superimposing. When the respiration electrodes collect impedance changes caused by rhythmic blood flow, this will happen. Placing the respiration electrodes correctly will reduce this effect. The liver and ventricle should avoid the connection of respiration electrode, so that the heart or pulsating flow won't generate artifact.

## 8.4 Resp Display

Resp wave is as shown in Fig. 8-2:

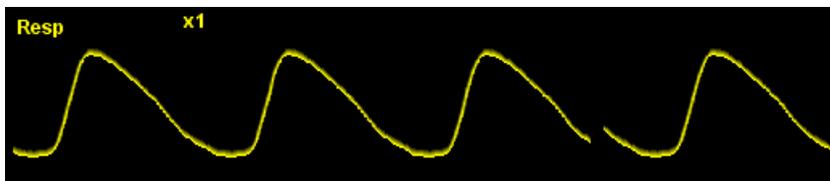


Fig. 8-2 Resp Wave

Resp parameters are displayed as shown in Fig. 8-3:



Fig. 8-3 Resp Parameter Area

## 8.5 Resp Setup

Click the ECG parameter zone or ECG wave area → [RESP Setup] menu, which is shown below. You can set Resp through [RESP Setup] menu.



Fig. 8-4 [RESP Setup] Menu

### **8.5.1 Setting Apnea Time**

Apnea alarm is a high level alarm for monitoring the apnea. In [RESP Setup] menu, set [Apnea Delay] to an appropriate value and set the apnea alarm time. When the apnea time of the patient is longer than the set time, the monitor will trigger an alarm. Default apnea alarm time is 20s.

### **8.5.2 Adjusting Wave Gain**

In [RESP Setup] menu, select [Gain], and set the wave gain: the greater gain, the higher wave amplitude.

### **8.5.3 Setting Scanning Speed**

In [RESP Setup] menu, select [Wave speed], and set the scanning speed: the faster scanning speed, the smoother wave.

## **8.6 Alarm Setup**

Select [Alarm Setup >>] to enter the [Alarm Setup] interface, and set the RESP alarm; see 6.5 Alarm Setup for the setting method.

# Chapter 9. PR

## 9.1 Overview

The mechanical activity of the heart causes arterial pulsation, and PR (pulse rate) value can be obtained by measuring this pulsation. PR value can be obtained through SpO2 measurement.

## 9.2 Display

The color of PR parameter area is same as SpO2 parameter color of PR source, as shown in Fig. 9-1:

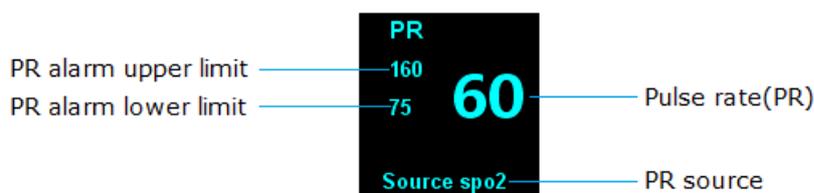


Fig. 9-1 PR Parameter Area

## 9.3 Setting PR Sound

Select SpO2 parameter area or Pleth wave area → [SpO2 Setup] menu;

Select [Pulse Vol.] to set [Pulse Vol.] to 0~9, and plus / minus 1 each time the shuttle is turned.

Select 0 to turn off the key-pressing tone, and select 9 to set the maximum volume.

### Note

- HR sound has higher priority than PR sound; when HR makes a sound, PR won't; when HR sound is 0, PR can make a sound.

## 9.4 Alarm Setup

Select PR parameter area → [SpO2 Setup] menu → [Alarm Setup >>] to enter the [Alarm Setup] interface, and set PR alarm switch, alarm level and upper/lower alarm limit. See 6.5 Alarm Setup for detailed setting method.

# Chapter 10. SpO<sub>2</sub>

## 10.1 Overview

Blood oxygen saturation (SpO<sub>2</sub>) is the percentage of oxyhemoglobin (HbO<sub>2</sub>) capacity bound by oxygen in the blood in the total hemoglobin (Hb) capacity that can be combined, that is, the concentration of oxygen in the blood.

The principle for monitoring the pulse SpO<sub>2</sub> is to fix the probe fingerstall on the patient's finger, use the finger as a transparent container for hemoglobin, use 660nm wavelength red light and 880nm near-infrared light as the incident light, maximum output power is 300 mw, measure the light transmission intensity through the tissue bed, and calculate the concentration of hemoglobin and SpO<sub>2</sub>.

The passing lights depend on a variety of factors, most of which are constant. However, one of these factors, the arterial blood flow, changes with time, as it is pulsating. By measuring the light absorbed during pulsating, it is possible to obtain the arterial blood SpO<sub>2</sub>. Detection pulsation can give a "plethysmography" wave and pulse rate signal.

The main screen displays "SPO<sub>2</sub>" value and "plethysmography" wave.

This monitor applies to measure SPO<sub>2</sub> of adults (>18 years), pediatric (30 Days to 18 years). Contact SPO<sub>2</sub> probe to Patient's finger to get "SPO<sub>2</sub>" value and "plethysmography" wave

SPO<sub>2</sub> function of this monitor has been calibrated in factory.

## 10.2 Safety Information



### Warning

- Please use SpO<sub>2</sub> sensor specified in this Manual, operate in accordance with the Manual, and observe all warnings and precautions.
- Before monitoring, check whether the sensor cable is normal. When SPO<sub>2</sub> sensor cable is unplugged from the socket, the screen will display [SPO<sub>2</sub>Sensor OFF] error message, and trigger an audible and visual alarm simultaneously.
- If the sensor or sensor packaging has signs of damage, do not use this SPO<sub>2</sub> sensor; return it to the manufacturer.

- If there is carboxyhemoglobin, methemoglobin or dye diluted chemical, the SPO2 value will have deviation.
- When the patient has a tendency to hypoxia, use the oximeter to analyze blood samples in order to fully grasp the patient's condition.
- Do not put the sensor on limbs with arterial duct or intravenous tube.
- Do not intertwine electrosurgical equipment cable with the sensor cable.
- Avoid using the monitor and sensors while using the NMR equipment, in order to avoid severe burns to the patient as a result of induced currents.
- During long time continuous monitoring of a patient, check the position of SpO2 sensor once every 2 hours, and move properly when the skin changes or every four hours. Some patients may require more frequent inspection, such as patients with perfusion disorders or sensitive skin, because persistent and prolonged monitoring may increase unpredictable skin changes, such as allergies, redness, blistering or pressure necrosis.
- Carefully select SpO2 alarm upper limit. High oxygen level will cause crystal-like fibrous tissue disease to premature children.

## Note

- Do not put the oxygen probe and blood pressure cuff on the same limb, because blood flow occlusion during blood pressure measurement will affect the SpO2 readings.
- This monitor cannot be used to verify the accuracy of SPO2 Probe and SPO2 machine.

## 10.3 Monitoring Steps

1. Select the appropriate SpO2 sensor according to the patient.
2. Turn on the monitor, and connect the SpO2 lead wire to the monitor.
3. Clean the measurement site, such as finger with nail polish.
4. Put the SpO2 sensor probe on the patient's body.
5. Select the appropriate alarm settings.
6. Start monitoring.

## Note

- Turn on the monitor, plug in SPO2 probe and connect patient's finger, monitor displays SPO2 wave, **【SPO2 Pulse Search】** displayed in the technical alarm area until the monitor measured SPO2 value and pulse rate. **【SPO2 Search Timeout】** displayed in the technical alarm area until the monitor measured pulse rate. Check the sensor mounting position, whether the sensor is damaged or sensor type. Reconnect the sensor or use new sensor.

## 10.4 Display

SpO2 parameter area is shown in Fig. 10-1.

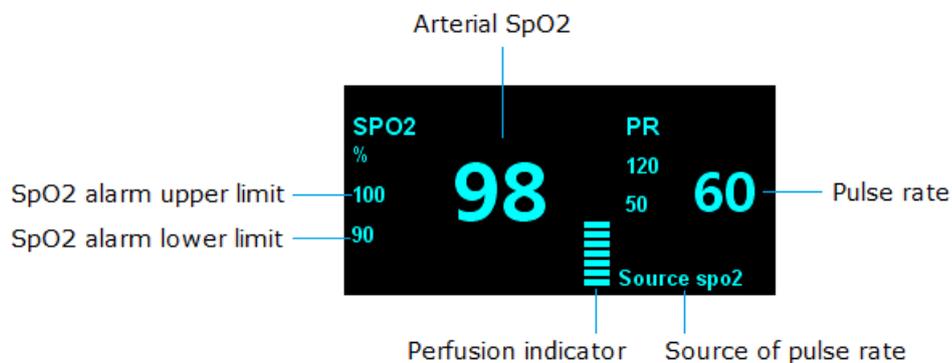


Fig. 10-1 SpO2 Parameter Area

SpO2 wave is shown in Fig. 10-2.

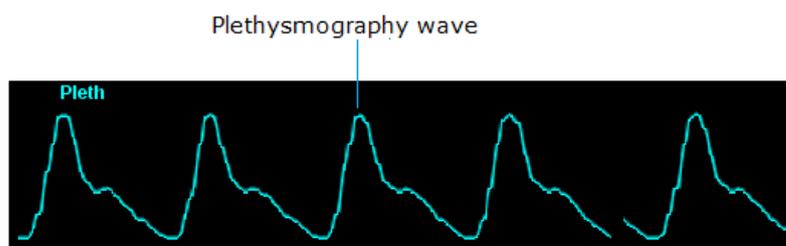


Fig. 10-2 SpO2 Wave

## 10.5 Setting SpO2

Select SpO2 parameter area or Pleth wave area → [SpO2 Setup] menu, which is shown below.

You can set SpO2 through [SpO2 Setup] menu.



Fig. 10-3 [SpO2 Setup] Menu

### 10.5.1 Setting Wave Speed

- Select [Wave Speed] and set wave speed to [12.5mm/s] or [25mm/s]; the faster speed, the smoother wave.

### 10.5.2 Setting Wave Mode

- Select [Wave Mode], and set the wave drawing mode
  - ◆ [Scan]: Scan mode.
  - ◆ [Fill]: Fill mode.

### 10.5.3 Setting Average Time

SpO<sub>2</sub> values displayed on the monitor are the results averaged from the data collected over time. The shorter the average time, the faster the monitor responds when the patient's SpO<sub>2</sub> value changes, but the measurement accuracy is lower. Conversely, the longer the average time, the slower the monitor responds when the patient's SpO<sub>2</sub> value changes, but the measurement accuracy is higher. In monitoring critically ill patients, a smaller average time is conducive to timely analysis of the disease.

The setting method follows:

- Select [Avg.Time] to set the average time to [2s], [3s], [4s], [5s], [6s], [7s] or [8s].

## 10.6 Measuring Influencing Factors

During operation, the following factors can affect the accuracy of SpO<sub>2</sub> measurement:

- High-frequency radio wave interference, such as interference generated by the host system or interference from electrosurgery instrument connected to the system.
- Intravenous dye.
- Too frequent movement of the patient.
- External light radiation.
- Sensor is improperly installed or improperly in contact with the patient.
- Sensor temperature (optimum temperature 28°C~42°C).
- The sensor is placed on limbs with blood pressure cuff, arterial duct or lumen tube.
- Concentration of non-functional hemoglobin such as carboxyhemoglobin (COHb) and methemoglobin (MetHb).
- SpO<sub>2</sub> too low.

- Poor perfusion of test site.
- Shock, anemia, hypothermia, and the application of vasoconstrictor drugs may reduce the arterial blood flow to a level that can not be measured.
- The measurement also depends on the absorption of specific wavelengths of light by oxyhemoglobin and reduced hemoglobin. If there is any other substance that absorbs the same wavelength, the measurement may have false or low SPO2 values, such as: carbon hemoglobin, methemoglobin, methylene blue, and indigo carmine.
- SPO2 probe described in Annex is recommended.
- Operating environment limit: Operating temperature range: 5~40°C, Humidity range: 0~80% (non-condensing), Elevation range: -500m~5000m.

## 10.7 Alarm Setup

In [SpO2 Setup] menu, select [Alarm Setup >>] to enter [Alarm Setup] interface, and set SPO2 alarm switch, alarm level, upper and lower alarm limit. See 6.5 Alarm Setup for detailed setting method.

# Chapter 11. NIBP

## 11.1 Overview

The monitor uses oscillometric method to measure noninvasive blood pressure (NIBP), and applies to adults, pediatric.

The oscillometric method for measuring blood pressure is to inflate a cuff with a certain amount of pressure until the arterial blood flow has been completely blocked. As pressure decreases, the arterial blood flow will be completely occluded, gradually opened, and completely opened. Then, the pulsation of the arterial vascular wall will generate a shock wave in the cuff. SBP, MBP, and DBP are obtained by measuring and analyzing cuff pressure oscillations when deflating.

- Produce first most clear signal - reflect SBP
- Oscillation amplitude reaches the peak - reflect MAP
- When the cuff pressure is suddenly lowered - reflect DBP

Measuring mode: manual, cycle, and continuous. Each mode shows systolic, mean and diastolic blood pressure.

- Manual mode

Using Manual mode start to measures by hand

- Automatic mode measures

Use manual mode to open automatic mode, then the measure will automatically turn to automatic mode after a certain time. During measurement. any error will stop the current automatic measurement, but not affect next automatic measurement unless the time interval less than 30s. If the time interval less than 30s, should delay the next automatic measurement, keep the interval more than 30s.

The time interval can be chosen in automatic mode as follow: 1, 2, 3, 4, 5, 10, 15, 30, 60, 90, 120, 180, 240, 480 minutes

- Continuous mode

Choose continuous mode, 5 seconds after completing a measurement start the next

measurement, continue 5 minutes then stop. During measurement. Any error will stop the continuous measurement. If the first measurement time is over 4 minutes and 40 seconds but less than 5 minutes, the continuous mode will stop before 5 minutes, If the first measurement time is over 5 minutes, the continuous mode will stop after 5 minutes

## 11.2 Safety Information



### Warning

- Do not carry out non-invasive blood pressure measurement on patients with sickle cell disease and skin damage or any expected damage.
- For patients with severe coagulation disorder, determine if the automatic blood pressure measurement is carried out according to the clinical evaluation, since the friction of body and cuff may produce hematoma.
- When measuring a child patient, ensure that the correct patient category (see Patient Info menu setting) is selected in order to ensure that maximum cuff pressure does not exceed the measuring range of the patient (pediatric mode: 240mmHg, Neonatal Mode: 150mmHg). Using the wrong patient mode may endanger the safety of patients because higher adult blood pressure level does not apply to children.
- Do not install a cuff on the limbs with intravenous infusion or duct, because it may lead to tissue damage around the duct when the cuff is inflated and makes the infusion slow down or be blocked.
- The inflatable tube connecting the blood pressure cuff and the monitor should be smooth without entanglement.
- For patients with severe thrombotic disorders, determine whether to carry out automatic blood pressure measurement according to the clinical situations, since the limb bundled with a cuff may produce hematoma.
- Measure blood pressure frequently will affect the distribution of blood flow, May endanger the safety of patients.
- Check the patient's physiological condition before measure blood pressure, in order to ensure that long time measure will not damage the circulation of patients
- Mastectomy patients, using NIBP cuff to measure blood pressure on the surgery side arm.

## 11.3 Measurement Limits

According to the patient's condition, the oscillometric method has some limitations. This measurement is to look for the regular pulse waves generated by arterial pressure. If the patient's condition makes this detection method difficult, the measured value becomes unreliable, and pressure measurement time increases. The user should be aware that the following conditions may interfere with measurement method, making the pressure measurement unreliable or extend the time. In this case, the patient's condition does not allow

measurement.

■ Patient movement

If the patient is moving, shaking or cramping, the measurement will be unreliable or even impossible, as these may interfere with the detection of arterial pressure pulse, and extend the pressure measurement time.

■ Arrhythmia

If the patient shows arrhythmia which results in irregular heartbeat, the measurement will be unreliable and even cannot be done, and the pressure measurement time will be extended.

■ Use of an artificial heart-lung machine

If a patient is connected to an artificial heart-lung machine, the measurement will be impossible.

■ Pressure changes

If the arterial pressure pulse is being analyzed to obtain a measured value at a certain time and the blood pressure of the patient changes rapidly, the measurement will be unreliable or impossible.

■ Severe shock

If the patient is in severe shock or hypothermia, the pressure measurement will not be reliable, because the decrease of blood flow to the periphery would cause decrease in arterial pulsation.

■ Limit heart rate

If the heart rate is below 40bpm (beats / min) or above 240bpm (beats / min), the blood pressure measurement is impossible.

■ Obese patients

A thick layer of fat around a limb blocks the arterial oscillation so that it cannot reach the cuff. The accuracy is lower than normal.

■ Environmental Requirements

Measure blood pressure should meet the environment range as follow: ambient humidity 15%~80%, no condensing, ambient temperature 0~45 °C, altitude -500m~5000m. NIBP performance and measurement accuracy will be affected beyond the range.

## 11.4 Measurement Procedure

### 11.4.1 Preparing for Measurement

1. Turn on the monitor, and check if it works properly;
2. Verify the patient category, and make changes if improper;
3. Connect the blood pressure cuff extension tube to the monitor;
4. Select the cuff in accordance with the following method, make sure that the cuff is completely deflated, and then tie it to the upper arm or thigh of the patient.
  - ◆ Determine the limb circumference of the patient.
  - ◆ Select the appropriate cuff (marked with appropriate limb circumference). Cuff width should be 40% of the limb circumference or 2/3 of the upper arm length. The length of the inflated part of the cuff should be sufficient for 50%~80% around the limb.
  - ◆ Place the cuff on the upper arm or thigh of the patient, and ensure that the marking  $\phi$  is located just above the appropriate artery. Make sure that the cuff does not wrap too tight around the limb, or it may cause distal discoloration or even ischemia.

### 11.4.2 Patient posture requirements during measurement

1. Sit comfortable or lie down relax;
2. No crossing legs
3. Back and elbow should be supported;
4. The center of NIBP cuff and the right atrium are at in the same level.
5. Remind patients, no talking during measurement and try to relax.

#### Note

- If there is any question of measurement value, please repeat measurement then get average value, if the average value is not correct, please change to mechanical blood pressure measurement equipment.

### 11.4.3 Starting / Stopping Measurement

Use the  buttons on the monitor panel or  [NIBP] smart hotkey on the display to start / stop the blood pressure measurement.

### 11.4.4 Correcting Measurement Results

The position of limb blood pressure measurement should be in the same horizontal position of the patient's heart. Otherwise, correct the measurement results with the following correction

method:

- If the cuff is above the heart level position, increase 0.75mmHg (0.10kPa) per centimeter of gap to the measured results.
- If the cuff is below the heart level position, subtract 0.75mmHg (0.10kPa) per centimeter of gap from the measured results.
- If the patient is obese or clothes are too thick, subtract 5mmHg ~ 10mmHg (0.65kPa ~ 1.3kPa) from the measured results.

## 11.5 NIBP Display

NIBP measurement has no waveform display, and only displays NIBP measurement results in the parameter area, as shown in Fig. 11-1. The figure below is for reference only. The graphics displayed on the monitor may be slightly different.

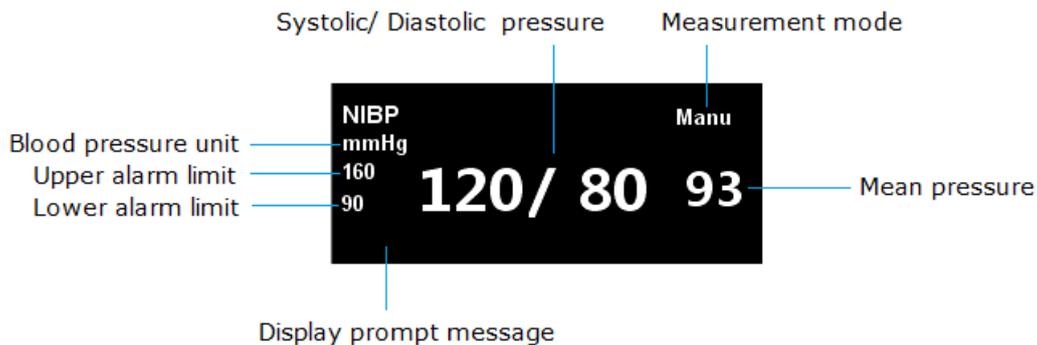


Fig. 11-1 NIBP Parameter Area

## 11.6 Setting Inflation Pressure

If necessary, you can manually set the initial cuff inflation pressure as follows:

- Select the NIBP parameter area → [NIBP Setup] menu;
- Select [Pre-Infl Press] and set the appropriate cuff pressure value.

## 11.7 NIBP Resetting

Select NIBP parameter area → [NIBP Setup] menu → Select [Reset], and restore the inflation pressure of the blood pressure pump to currently configured initial settings. When the blood

pressure pump is not working properly, but no warning is given, you can reset the blood pressure pump, and automatically restores the blood pressure pump.

## 11.8 NIBP Leakage Test

The purpose of leakage test is to detect if the sealing of the air passage is in good condition. If the leakage test passes, the NIBP parameter area displays [Leakage test Stopped]. If not passed, the NIBP parameter area displays [Cuff leak] message. NIBP leakage test shall be at least once every two years or when you think that the reading is not accurate.

Prepare the following materials before the test:

- Adult cuff: one
- Inflation tube: one
- Cylinder of appropriate size: one

Leakage test process

1. Connect the cuff to the NIBP pore of the monitor
2. Wrap the cuff on the cylinder of appropriate size.
3. Set the patient category to adults.
4. Select  [Menu] Smart Hotkey → [Main Menu];
5. Select [User Maintenance >>] → enter the password and confirm → [User Maintenance] menu;
6. Select [Module Maintenance >>] → [Module Maintenance] menu;
7. Select [NIBP >>] → [NIBP Maintenance] menu, and select [Leak Test] for leakage test.
8. After 20s, the system will automatically open the bleeder valve, and the leak test finishes.
9. If the NIBP parameter area displays [Leakage test Stopped], the system does not leak. If it displays [Cuff leak], it indicates that the air passage leaks. At this time, the operator should check if the entire connection is loose, and test for leak once again when the connection is correct. If there is error prompt still, please contact the manufacturer for repair.

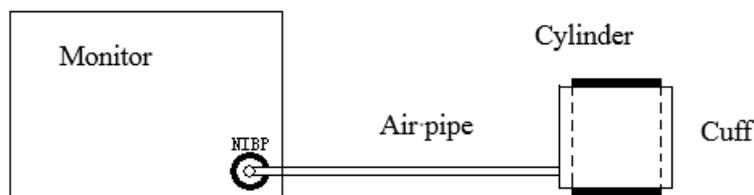


Fig. 11-2 NIBP Leakage Test Connection Diagram

## 11.9 NIBP Calibration

Users can not calibrate NIBP. If calibration is required, please contact your service representative. Cuff pressure sensor should be checked and calibrated at least once every two years by qualified professional service personnel.

## 11.10 Clean and disinfection method of NIBP cuff

If necessary, NIBP cuff and NIBP extension tube can be cleaned and disinfected together without separated

### 11.10.1 Cleaning Method

1. Prepare enzyme cleaning agent, distilled water and 10% solvent, respectively in different spray bottle.
2. Sprinkle cleaning agent on NIBP cuff, connector and extension tube, keep 1 minutes for the dry stains.
3. Use a soft cloth to wipe smooth face. Use soft hair brush to brush visible stain and irregular surface

#### Note

- Please be especially careful to clean the air ball and control valve of whole air system. Do not allow any liquid entering into reversing valve and saturated valve
- Don't use a soft cotton ball and fiber to clean this accessory, because they will stick on the cuff and extension tub

### 11.10.2 Disinfection Method

1. Sprinkle bleach solution (Formula: the proportion of water and bleaching powder to 1:10) then keep 5 minutes
2. Wipe off excess bleach solution and elute with distilled water again
3. Natural dry cuff

## 11.11 Alarm Setup

In [NIBP Setup] menu, select [Alarm Setup >>] to enter [Alarm Setup] interface, and set NIBP alarm switch, alarm level, upper and lower alarm limit. See 6.5 Alarm Setup for detailed setting method.

# Chapter 12. Temp

## 12.1 Overview

This monitor has two temperature measurement channels; the temperature sensor will measure the body temperature and calculate the difference between the body temperature data.

## 12.2 Safety Information



### Warning

- **Before monitoring, check if the probe cable is normal. Unplug the temperature probe cable from the jack, the screen will display [TEMP1/TEMP2 Sensor Off] prompt and make an alarm sound.**
- **Calibrate the temperature measuring instrument at least once every two years (or according to hospital procedures). When calibration is required, please contact the manufacturer.**

## 12.3 Measurement Steps

Please refer to the following steps:

1. Turn on the monitor and check if it works normally.
2. Select the appropriate temperature probe according to the patient category and measurement needs.
3. Insert the probe lead wire into the temperature probe interface.
4. Attach the probe to the patient properly.
5. Make sure that the alarm settings apply to the patient.

## 12.4 Measuring Requirements

The normal measuring range of body temperature is 5~50°C, and the accuracy is consistent in this range.

The environmental temperature range for body temperature measuring is 0~55°C, the minimum measuring time is 1s, and the measuring interval is 1s.

## Warning

- Please measure the body temperature in the specified environmental temperature range, or else it may be dangerous.

## 12.5 Temp Display

The monitor can display the body temperature of two channels (T1 and T2) and the alarm limits, difference between the two temperature (TD) and temperature units. Select Temp parameter area and open the [Temp Setup] menu.

Temp display area is shown below:

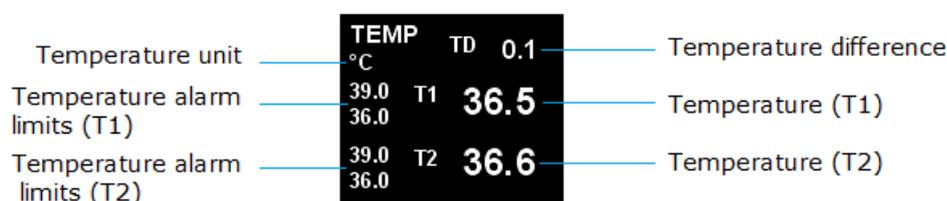


Fig. 12-1 TEMP Parameter Area

## 12.6 Selecting Resistance Type of Temp Probe

Select the appropriate [Temp Sensor] value according to the actual resistance of the temperature probe being used. The specific setting method follows:

- Select  [Menu] smart hotkey → [Main Menu];
- Select [Factory Maintenance] → Enter and confirm the password → [Factory Maintenance] menu;
- In [Factory Maintenance] menu, set [Temp Sensor] to
  - ◆ [10K], probe resistance is 10kΩ;
  - ◆ [2K], probe resistance is 2.25kΩ.

## Warning

- If the temperature value displayed by the monitor has significant difference from the body temperature under normal condition, please check if the probe resistance of the monitor matches the

**resistance set in the monitor system; if not, please replace a probe with appropriate resistance or adjust the monitor and select the appropriate resistance.**

## 12.7 Setting Temperature Unit

You can define your favorite temperature unit as follows:

- Select TEMP parameter area → [TEMP Setup] menu;
- In the [TEMP Setup] menu, set [Unit] to [°C] or [°F].

## 12.8 Alarm Setup

In [TEMP Setup] menu, select [Alarm Setup >>] to enter [Alarm Setup] interface, and set TEMP alarm switch, alarm level, upper and lower alarm limit. See 6.5 Alarm Setup for detailed setting method.

## Chapter 13. Review

The monitor provides up to 120 hours trend data review of all monitoring parameters, 1000 groups of NIBP measurement data and 200 alarm events. The user can select trend chart or trend table to view trend change; or view the latest wave.

### 13.1 Reviewing Trend Chart

Select  [Review] smart hotkey to enter [Review] menu, and select [Graphic] to enter the following window.

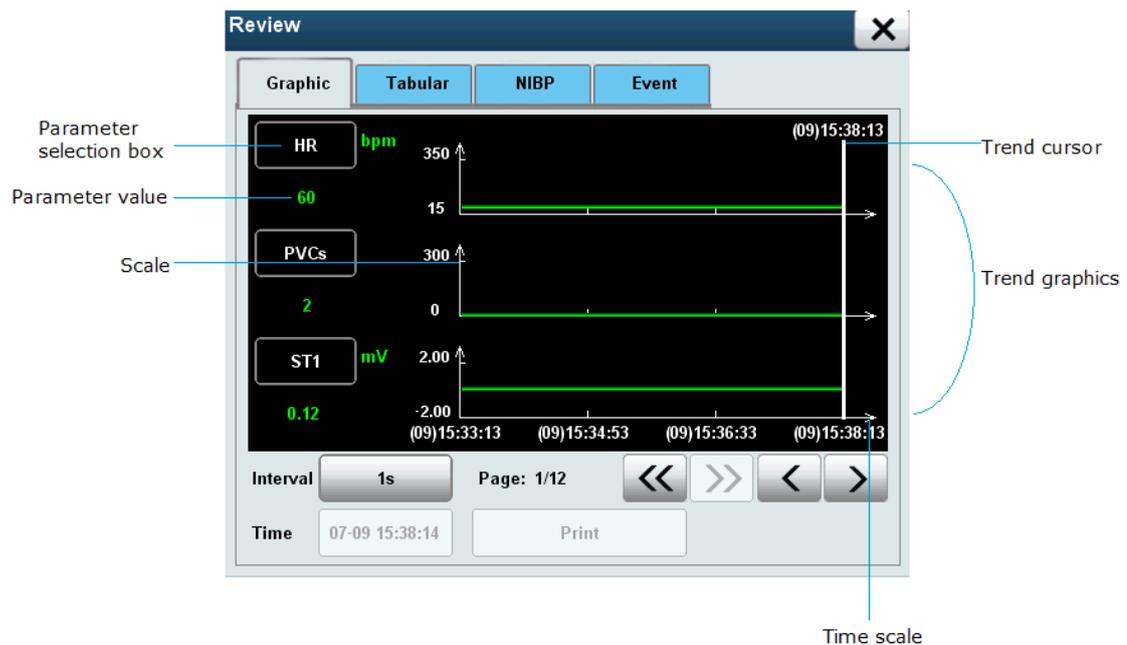


Fig. 13-1 Trend Chart

- In the trend chart, use the following method to select the parameter to be reviewed:
  - ◆ Select the parameter box, rotate the shuttle to select the parameters to be reviewed, click on the shuttle, and set the parameter box as the parameter to be reviewed.
- Select [Interval], and select the option as needed:
  - ◆ [1s]: observe the trend of the last hour at 1sec interval.
  - ◆ [5s]: observe the trend of the last eight hours at 5sec interval.
  - ◆ [1min]: observe the trend of the last 120 hour at 1min interval.
  - ◆ [5min]: observe the trend of the last 120 hour at 5min interval.
  - ◆ [10min]: observe the trend of the last 120 hour at 10min interval.

- ◆ [30min]: observe the trend of the last 120 hour at 30min interval.
- ◆ [60min]: observe the trend of the last 120 hour at 60min interval.
- Browse the trend chart in the following method:
  - ◆ Select  and  to move the trend cursor.
  - ◆ Select  and  to turn pages to left or right and move the trend chart.
  - ◆ The cursor top displays the current time corresponding to the current cursor position, and the left of the trend chart window displays the parameter values of the time, which will change automatically with the move of trend cursor.

## 13.2 Reviewing Trend Table

Select  [Review] smart hotkey to enter [Review] menu, select [Tabular] and enter the following window.



Time	HR	PVCs	ST1	ST2	SP02
14:15:58	60	2	0.12	0.32	98
14:15:57	60	2	0.12	0.32	98
14:15:56	60	2	0.12	0.32	98
14:15:55	60	2	0.12	0.32	98
14:15:54	60	2	0.12	0.32	98
14:15:53	60	2	0.12	0.32	98
14:15:52	60	2	0.12	0.32	98

Interval: 1s

Time: 07-09 14:15:58

Buttons: Define Group>>, Print

Fig. 13-2 Trend Table

- Select [Interval], and select the option as needed:
  - ◆ [1s]: observe the data of the last hour at 1sec interval.
  - ◆ [5s]: observe the data of the last eight hours at 5sec interval.
  - ◆ [1min]: observe the data of the last 120 hour at 1min interval.
  - ◆ [5min]: observe the data of the last 120 hour at 5min interval.
  - ◆ [10min]: observe the data of the last 120 hour at 10min interval.
  - ◆ [30min]: observe the data of the last 120 hour at 30min interval.

- ◆ [60min]: observe the data of the last 120 hour at 60min interval.
- Browse the trend table in the following method:
  - ◆ Select  and  to turn pages to left or right and move the trend table to observe the target parameters.
  - ◆ Select  and  to move the trend table upward or downward progressively and observe more data.
  - ◆ Select  and  to turn pages up or down and move the trend table to observe more data.

### 13.3 NIBP Measurement Review

Select  [Review] smart hotkey to enter [Review] menu, and select [NIBP] to enter the following window



The screenshot shows a window titled "Review" with a close button (X) in the top right corner. Below the title bar are four tabs: "Graphic", "Tabular", "NIBP", and "Event". The "NIBP" tab is selected. The main area contains a table with the following data:

NIBP	Sys	Dia	Mean	PR
14:15:30	120	80	93	60
14:15:00	120	80	93	60
14:14:30	120	80	93	60
14:13:30	120	80	93	60
14:13:00	120	80	93	60
14:12:30	120	80	93	60
14:12:00	120	80	93	60
14:11:30	120	80	93	60
14:11:00	120	80	93	60

At the bottom of the window, there is a "Page: 1/2" indicator, four navigation buttons (up double arrow, down double arrow, up single arrow, down single arrow), and a "Print" button.

Fig. 13-3 Measurement of NIBP Review

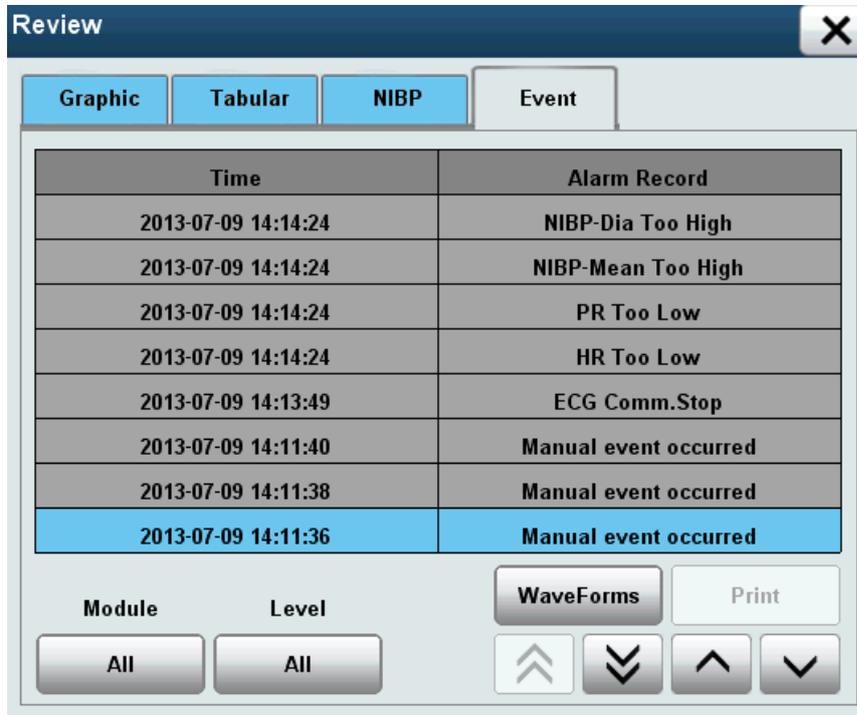
This window shows the measurement time of noninvasive blood pressure, systolic blood pressure [Sys], diastolic blood pressure [Dia], mean blood pressure [Mean] and pulse rate [PR]. The monitor can store 1000 sets of NIBP measurements in total.

- NIBP viewing method is as follows:

- ◆ Select  and  to move the trend table upward or downward progressively and observe more data.
- ◆ Select  and  to turn pages up or down and move the trend table to observe more data.

## 13.4 Event Review

Select  [Review] smart hotkey to enter [Review] menu, and select [Event] to enter the following window.



The screenshot shows the 'Review' window with the 'Event' tab selected. The window contains a table with two columns: 'Time' and 'Alarm Record'. The table lists several events, with the most recent one highlighted in blue. Below the table are controls for 'Module' and 'Level', both set to 'All', and buttons for 'WaveForms', 'Print', and navigation arrows.

Time	Alarm Record
2013-07-09 14:14:24	NIBP-Dia Too High
2013-07-09 14:14:24	NIBP-Mean Too High
2013-07-09 14:14:24	PR Too Low
2013-07-09 14:14:24	HR Too Low
2013-07-09 14:13:49	ECG Comm.Stop
2013-07-09 14:11:40	Manual event occurred
2013-07-09 14:11:38	Manual event occurred
2013-07-09 14:11:36	Manual event occurred

### 13.4 Event Review

This window shows the time of alarm events and corresponding alarm information, and the time of manual events and corresponding manual tag events. This monitor allows reviewing 200 events in total, including the physiological alarm events, technical alarm events and manual events.

- Select [Module], and select an option as needed:
  - ◆ [ECG]: View ECG-related alarm events.
  - ◆ [SPO2]: View SPO2 related alarm events.
  - ◆ [NIBP]: View NIBP related alarm events.

- ◆ [RESP]: View RESP related alarm events.
  - ◆ [TEMP]: View TEMP related alarm events.
  - ◆ [Manual]: View manual events.
  - ◆ [All]: View all related events.
- Select [Level], and select an option as needed:
    - ◆ [High]: View high level alarm events.
    - ◆ [Mid]: View middle level alarm events.
    - ◆ [Low]: View low level alarm events and manual events.
  - Select [Wave Forms] to view the waveform and relevant parameters when alarm occurs, as shown in Fig. 13.5 below:

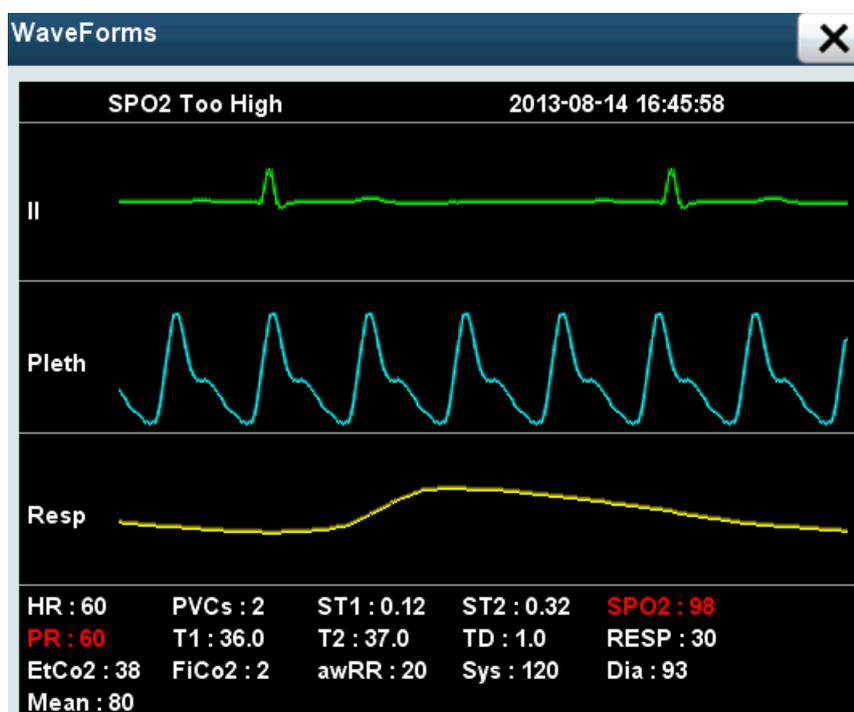


Fig. 13.5 Waveform Review

- Event viewing method is as follows:
  - ◆ Select  and  to move the trend table upward or downward progressively and observe more data.
  - ◆ Select  and  to turn pages up or down and move the trend table to observe more data.

# Chapter 14. Gas Monitoring

## 14.1 CO<sub>2</sub> Monitoring (optional)

### 14.1.1 Introduction

CO<sub>2</sub> monitoring is a continuous, non-invasive technique for determining the concentration of CO<sub>2</sub> in the patient's airway by measuring the absorption of infrared (IR) light of specific wavelengths. The CO<sub>2</sub> has its own absorption characteristic and the amount of light passing the gas probe depends on the concentration of the measured CO<sub>2</sub>. When a specific band of IR light is passed through respiratory gas samples, some of IR light will be absorbed by the CO<sub>2</sub> molecules. The amount of IR light transmitted after it has been passed through the respiratory gas sample is measured with a photodetector. From the amount of IR light measured, the concentration of CO<sub>2</sub> is calculated.

There are two kinds of CO<sub>2</sub> measuring modules:

1. Mainstream (IRMA) measurement uses a CO<sub>2</sub> sensor attached to an airway adapter directly inserted into the patient's breathing system.
2. Sidestream (ISA) measurement samples expired patient gas at a constant sample flow from the patient's airway and analyzes it with a CO<sub>2</sub> sensor built into the CO<sub>2</sub> module.

The measurement provides:

1. A CO<sub>2</sub> waveform.
2. End tidal CO<sub>2</sub> value (EtCO<sub>2</sub>): the CO<sub>2</sub> value measured at the end of the expiration phase.
3. Fraction of inspired CO<sub>2</sub> (FiCO<sub>2</sub>): the smallest CO<sub>2</sub> value measured during inspiration.
4. Airway respiration rate (awRR): the number of breaths per minute, calculated from the CO<sub>2</sub> waveform.



CO<sub>2</sub> Parameter and waveform

## 14.2 Anesthetic Gases Monitoring (optional)

### 14.2.1 Introduction

Anesthetic gas (AG) module is used to measure the gases N<sub>2</sub>O, CO<sub>2</sub>, O<sub>2</sub> (optional) and anesthetic agents from patient respiratory gas. Patient's anesthesia depth and physiological function of disturbance have a close relationship. Monitoring of anesthetic gas concentration plays an important role in guiding the implement of anesthesia and improving anesthesia safety.

The theoretical basis of anesthetic gas measurement is that different gases absorb certain wavelengths of infrared (IR) light. The process of anesthesia module analyzing patients' respiratory gas is continuously measuring infrared absorption rate of airflow through the infrared spectrometer.

The measurement of degree of oxygen absorption is based on paramagnetic technology. The principle of paramagnetic oxygen measurement is according to the magnetization sensitivity of the magnetic field to distinguish between oxygen and other gases. Oxygen will be attracted by magnetic field, because of oxygen with paramagnetic

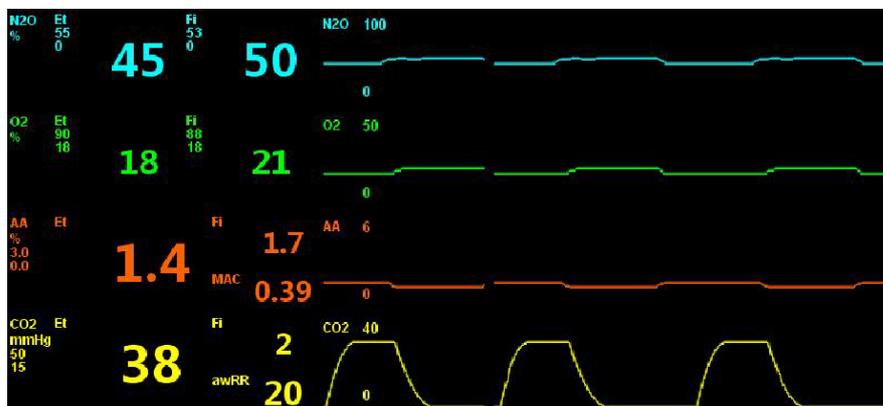
The monitor supports two kinds of anesthesia modules:

1. IRMA mainstream module
2. ISA sidestream module

Anesthetic gas module provides the following exhalation and inhalation gas values:

1. CO<sub>2</sub>: end-tidal carbon dioxide- EtCO<sub>2</sub> and inhalation carbon dioxide-FiCO<sub>2</sub>
2. O<sub>2</sub> (optional): Exhalation oxygen-EtO<sub>2</sub> and inhalation of oxygen-FiO<sub>2</sub>
3. N<sub>2</sub>O: end-tidal nitrous oxide and inhalation nitrous oxide-FiN<sub>2</sub>O
4. Anesthetic Agent (AA): Anesthesia gases DES, ISO, ENF, SEV and HAL.
5. AWRR: breaths per minute
6. MAC: The minimum alveolar concentration of inhalation anesthetics that can make 50% of the patients at an atmospheric pressure do no dynamic response when cut in the skin. MAC value is a basic indicator of inhalation anesthesia depth.

#### AG Display



AG parameters and waveforms

AG module will display the measured waveforms and parameters on the monitor screen:

CO<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>O, AA (Et and Fi values)

AWRR: CO<sub>2</sub>, O<sub>2</sub>, AA and N<sub>2</sub>O

**Waveform:** The monitor can also show up to 4 waveforms for anesthetic gases at the same time. When AG module identifies two anesthetic gases, AA waveform shows the main anesthetic gas. Parameter area only supports the inspiratory and expiratory value of the main anesthetic gas. The O<sub>2</sub> waveform is displayed according to whether the module of O<sub>2</sub> is configured.

**MAC:** Minimum alveolar concentration

The MAC is the concentration of the vapor (measured as a percentage at 1 atmosphere, i.e. the partial pressure) that prevents patient movement in response to a supramaximal stimulus (traditionally a set depth and width of skin incisions) in 50% of subjects. This measurement is done at steady state (assuming a constant alveolar concentration for 15 minutes), under the assumption that this allows for an equilibration between the gasses in the alveoli, the blood and the brain. MAC is accepted as a valid measure of potency of inhalational general anesthetics because it remains fairly constant for a given species even under varying conditions.

According to the following formula, using the end-tidal gas concentration, the MAC value can be calculated:

$$\text{MAC} = \frac{\% \text{Et}(\text{AA1})}{\text{X}(\text{AA1})} + \frac{\% \text{Et}(\text{AA2})}{\text{X}(\text{AA2})} + \frac{\% \text{Et}(\text{N2O})}{100}$$

Et(AA1): the value of the end-tidal concentration of primary anesthetic gas

Et(AA2): the value of the end-tidal concentration of second anesthetic gas

Et(N<sub>2</sub>O): the value of the end of primary breathing N<sub>2</sub>O

X(AA1): The 1 MAC density corresponding to inhalation primary anesthetic gas

X(AA2): The 1 MAC density corresponding to second inhalation anesthetic gas

The 1 MAC density of every inhalation anesthetic gas:

Anesthetics	HAL	ISO	ENF	SEV	DES
X(AA)	0.75%	1.15%	1.7%	2.05%	6.0%

For example: AG module measures the gases at the end of the patient breath:

DES=4%, HAL=0.5%, N<sub>2</sub>O=50% so the value of MAC:

$$\text{MAC} = \frac{4\%}{6.0\%} + \frac{0.5\%}{0.75\%} + \frac{50\%}{100} = 1.83$$



#### Attention

- None of the above formula considering altitude, patient age and other personal factors. EtAA2 could only be used for IRMA AX+/OR+ probes.

### 14.3 Mainstream Gas Analyzer

#### 14.3.1 Intended use

The IRMA mainstream gas analyzer is intended to be connected to other medical devices for monitoring of breath rate and the breathing gases CO<sub>2</sub>, N<sub>2</sub>O and the anesthetic agents Halothane, Enflurane, Isoflurane, Sevoflurane and Desflurane.

It is intended to be connected to a patient breathing circuit for monitoring of inspired/expired gases during anesthesia, recovery and respiratory care. It may be used in the operating suite, intensive care unit and patient room for adult, pediatric and infant patients. IRMA CO<sub>2</sub> may also be used in the emergency medical services environment and road ambulances.

**Note:** An IRMA mainstream gas analyzer shall only be connected to medical backboard devices approved by Masimo Sweden AB.

#### 14.3.2 Symbols

Symbol	Title	Explanation
	Follow instructions for use	Follow IRMA User's Guide and user documentation for the medical backboard device
	Use by date [YYYY-MM-DD]	Indicates that the device should not be taken into operation after the date accompanying the symbol (IRMA Airway Adapters)
	Do not re-use	Intended for single patient use (IRMA Airway Adapters)
<b>IP44</b>	IP classification indicating degree of protection against ingress of solid foreign objects and water	IP44 - protection against solid objects over 1mm and water splashed from all directions

For the complete list of symbols see section 14.3.16 Technical Specification (in English only).

### 14.3.3 Technical specification

Operating temperature	IRMA CO2: 0–40°C / 32–104°F      IRMA AX+: 10–40°C / 50–104°F
Operating atmospheric pressure	525–1200 hPa (525 hPa corresponding to an altitude of 5 211 m / 17 100 feet)
Surface temperature (at ambient temp. 23°C)	IRMA CO2: Max 39°C / 102°F      IRMA AX+: Max 46°C / 115°F
Respiration rate	0–150 ±1 bpm. The respiration rate is displayed after three breaths and the average value is updated every breath.
Warm-up time	IRMA CO2: < 10 seconds (concentrations reported and full accuracy) IRMA AX+: < 20 seconds (concentrations reported, automatic agent identification enabled and full accuracy).
Warm up time after storage at –40°C (IRMA CO2 only)	A warm up period of 15 minutes <sup>1</sup> is required for IRMA CO2 to fulfill the accuracy specification if immediately put into use in 20°C ambient temperature after being stored at –40°C.
Primary agent threshold (IRMA AX+ only)	0.15 vol%. When an agent is identified, concentrations will be reported even below 0.15 vol% as long as apnea is not detected.
Secondary agent threshold (IRMA AX+ only)	0.2 vol% + 10% of total agent concentration
Agent identification time	< 20 seconds. (Typically < 10 seconds)
Total system response time	< 1 second

#### Accuracy – standard conditions

The following accuracy specifications are valid for dry single gases at 22 ± 5 °C and 1013 ± 40 hPa

Gas	Range	Accuracy
CO <sub>2</sub>	0 to 15 vol%	±(0.2 vol% + 2% of reading)
N <sub>2</sub> O	0 to 100 vol%	±(2 vol% + 2% of reading)
HAL, ISO, ENF	0 to 8 vol%	±(0.15 vol% + 5% of reading)
SEV	0 to 10 vol%	±(0.15 vol% + 5% of reading)
DES	0 to 22 vol%	±(0.15 vol% + 5% of reading)

<sup>1</sup> A "Change Adapter" message may appear if immediately put into use after being stored at -40°C; the message can be ignored if automatically restored after the warm up period.

For complete specifications see section 14.3.16 Technical Specification (in English only).

#### 14.3.4 IRMA Airway Adapter

The IRMA Airway Adapter is inserted between the endotracheal tube and the Y-piece of the breathing circuit. The respiratory gas measurements are obtained through the XTP™ windows in the sides of the adapter. The XTP windows are transparent to light in the wavelength ranges of interest and they are specially designed using the latest advances in material technology to provide a window minimizing the impact of water vapor on light transmission.



**Warning:** Replace the airway adapter if rainout/condensation occurs inside the airway adapter.

The IRMA Airway Adapter is designed as a non-sterile single patient use disposable for both Adult/Pediatric and Infant applications. The IRMA Infant Airway Adapter has specially designed connectors for minimizing the dead space and can be used even for very small patients.



*IRMA Airway Adapters: Adult/Pediatric (MASIMO REF 106220) and Infant (MASIMO REF 106260)*



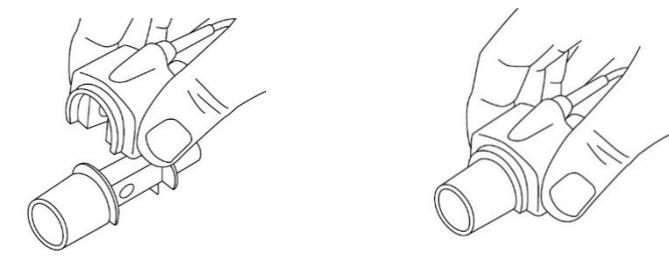
**Warning:** Do not use the IRMA Adult/Pediatric Airway Adapter with infants as the adapter adds 6 ml dead space to the patient circuit.



**Warning:** Do not use the IRMA Infant Airway Adapter with adults/pediatrics as this may cause excessive flow resistance.

#### 14.3.5 System set-up

1. Connect the IRMA probe interface cable to the CO<sub>2</sub> / GAS connector of the patient monitor and switch the power on. The interface cable connector is used as disconnecting device.
2. Snap the IRMA probe on top of the IRMA airway adapter. It will click into place when properly seated.



3. Depending on IRMA model, perform the following:

**IRMA AX+**

- Wait minimum 30 seconds
- Perform zeroing (see section 1.8)

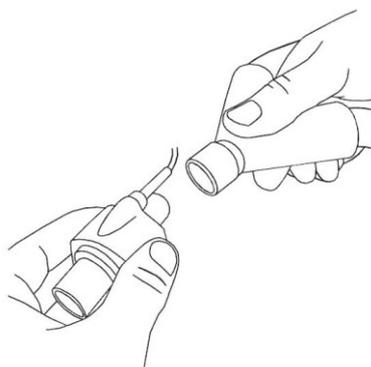
**IRMA CO2**

- Wait minimum 10 seconds
- Perform zeroing (see section 1.8) if gas readings does not show 0% or if an unspecified accuracy message is displayed

4. A green LED indicates that the IRMA probe is ready for use.



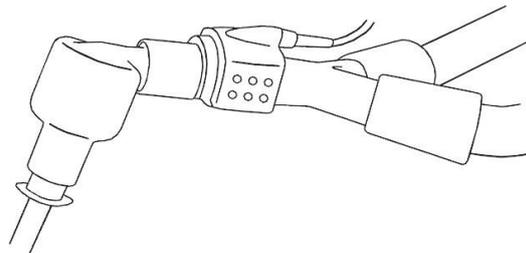
5. Connect the IRMA Airway Adapter 15 mm male connector to the breathing circuit Y-piece.





6. Connect the IRMA Airway Adapter 15 mm female connector to the patient's endotracheal tube.

Alternatively; connect a HME (Heat Moisture Exchanger) between the patient's endotracheal tube and the IRMA probe. Placing a HME in front of the IRMA probe protects the airway adapter from secretions and effects of water vapor and eliminates the need of



changing the adapter. It allows free positioning of the IRMA probe as well.

7. Unless the IRMA probe is protected with a HME always position the IRMA probe with the status LED pointing upwards.

#### 14.3.6 Placement of IRMA Probe

When connecting the IRMA probe to an infant patient circuit it is important to avoid a direct contact between the IRMA probe and the infant's body due to the elevated surface temperature of the IRMA Probe.



**Warning:** If, for whatever the reason, the IRMA probe is in direct contact with any parts of the infant's body an insulation material shall be placed between the IRMA probe and the body.



**Warning:** The IRMA probe is not intended to be in patient contact.

### 14.3.7 Pre-use check

Always verify gas readings and waveforms on the medical backboard device before connecting the IRMA Airway Adapter to the patient circuit.

Perform the tightness check of the patient circuit according to the User Manual for the medical backboard device with the IRMA probe snapped on the IRMA Airway Adapter.

### 14.3.8 Zeroing



**Warning:** Incorrect probe Zeroing will result in false gas readings.

In order to secure high precision of the IRMA probe measurements the following zeroing recommendations should be followed:

Zeroing is performed by snapping a new IRMA Airway Adapter onto the IRMA probe, without connecting the airway adapter to the patient circuit, and then using the patient monitor to transmit a zero reference command to the IRMA probe.

- Open [CO2 setup] menu, select [Zeroing] button, IRMA module starting zeroing. During the process of zeroing, the green LED of the probe flashes for about 5s.

Special care should be taken to avoid breathing near the airway adapter before or during the zeroing procedure. The presence of ambient air in the IRMA Airway Adapter is of crucial importance for a successful zeroing. If a "ZERO\_REQ" alarm should appear directly after a zeroing procedure, the procedure has to be repeated.

Always perform a pre-use check after zeroing the probe.

#### **IRMA CO2 probes:**

Zeroing needs to be performed **ONLY** when an offset in gas values is observed, or when an unspecified accuracy message is displayed.

Allow 10 seconds for warm up of the IRMA CO2 probes after power on before proceeding with the zeroing procedure.

Allow the IRMA probe to warm up for at least 10 seconds after changing the IRMA Airway Adapter before transmitting the zero reference command.

#### **IRMA AX+ probes:**

Zeroing should be performed **every time the IRMA Airway Adapter is replaced**, or whenever an offset in gas values or an unspecified gas accuracy message is displayed.

Allow 30 seconds for warm up of the IRMA AX+ probes after power on and after changing the IRMA Airway Adapter before proceeding with the zeroing procedure. The green LED on the probe will be blinking for approximately 5 seconds while zeroing is in progress.

#### 14.3.9 Alarms

See User Manual Appendix C for a complete description of the alarm handling related to the IRMA mainstream gas analyzer.

##### **Status LED on the IRMA probe:**

Indication	Status
Steady green light	System OK
Blinking green light	Zeroing in progress
Steady blue light <sup>2</sup>	Anesthetic agent present
Steady red light	Sensor error
Blinking red light	Check adapter

#### 14.3.10 Cleaning

The IRMA probe can be cleaned using a cloth moistened with ethanol or isopropyl alcohol (< 70%).

**Caution:** The IRMA Airway Adapters are non-sterile devices. Do not autoclave the devices as this will damage them.

**Caution:** Never sterilize or immerse the IRMA probe in liquid.

#### 14.3.11 Gas span check

Gas readings should be verified at regular intervals with a reference instrument or with calibration gas. The suggested interval for gas span check is once every year. Calibration gases shall be handled and disposed of in accordance with local regulations.

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<sup>2</sup> Valid for IRMA AX+ only

### 14.3.12 Warnings



The IRMA probe is intended for use by qualified medical personnel only.

The IRMA probe is intended only as an adjunct in patient assessment. It must be used in conjunction with other assessments of clinical signs and symptoms.

Disposable IRMA Airway Adapters shall not be reused. Reuse of the single use adapter can cause cross infection.

Used airway adapters shall be disposed of in accordance with local regulations for biohazardous waste.

Do not use the IRMA Adult/Pediatric Airway Adapter with infants as the adapter adds 6 ml dead space to the patient circuit.

Do not use the IRMA Infant airway adapter with adults/pediatrics as this may cause excessive flow resistance.

Use of high frequency electrosurgical equipment in the vicinity of IRMA may produce interference and cause incorrect measurements.

The IRMA probe is not designed for MRI-environments.

Do not place the IRMA Airway Adapter between the endotracheal tube and an elbow as this may allow patient secretions to block the adapter windows and result in incorrect operation.

To keep secretions and moisture from pooling on the windows, always position the IRMA probe in a vertical position with the LED pointing upwards.

Do not use the IRMA Airway Adapter with metered dose inhalers or nebulized medications as this may affect the light transmission of the airway adapter windows.

Incorrect probe zeroing will result in false gas readings.

Replace the airway adapter if rainout/condensation occurs inside the airway adapter.

Use only Masimo manufactured IRMA Airway Adapters.

The IRMA probe is not intended to be in patient contact.

If, for whatever the reason, the IRMA probe is in direct contact with any parts of the infant's body an insulation material shall be placed between the IRMA probe and the body.

No modification of this equipment is allowed.

Measurements can be affected by mobile and RF communications equipment. It should be assured that the IRMA probe is used in the electromagnetic environment specified in this manual.

### 14.3.13 Cautions

Never sterilize or immerse the IRMA probe in liquid.

The IRMA airway adapters are non-sterile devices. Do not autoclave the devices as this will damage them.

Do not apply tension to the probe cable.

Do not operate the IRMA probe outside the specified operating temperature environment.

(U.S. only) Caution: Federal law restricts this device to sale by or on the order of a physician. For professional use. See instructions for use for full prescribing information, including indications, contraindications, warnings, precautions and adverse events.

### 14.3.14 Classifications

According to the degree of protection against harmful ingress of water or particulate matter:

- IP44

According to sterility

- The IRMA system contains no sterile parts.

According to the mode of operation

- CONTINUOUS OPERATION

According to the degree of protection against electric shock:

- The IRMA probe is classified as DEFIBRILLATION-PROOF TYPE BF APPLIED PART

The combination of a medical backboard device and IRMA shall be considered a ME SYSTEM.

### 14.3.15 Troubleshooting

See User Manual for the medical backboard device for a complete description of the specific technical alarm messages displayed by the patient monitor. Additional information about Status LED on the IRMA probe is found in Appendix C

Error Message	Indication	Recommended Action
No Adapter <sup>3</sup>	Indicates that an IRMA Airway Adapter needs to be installed.	Connect an IRMA Airway Adapter (refer to section 0).
Replace Adapter <sup>3</sup>	Indicates that the IRMA Airway Adapter needs to be replaced with a new one.	Replace the IRMA Airway Adapter with a new one.

<sup>3</sup> Optional message text; Check Adapter

Ambient Pressure out of Range <sup>4</sup>	Indicates ambient pressure measurement is out of range.	Verify standard operating conditions according to section 1.3; if normal replace the IRMA gas analyzer.
Temperature out of Range <sup>4</sup>	Indicates that the internal temperature is out of range.	Verify standard operating conditions according to section 14.3.3; if normal replace the IRMA gas analyzer.
Software error <sup>5</sup>	Indicates software error in the IRMA gas analyzer.	If persistent, replace the IRMA gas analyzer.
Hardware error <sup>5</sup>	Indicates hardware error in the IRMA gas analyzer.	If persistent, replace the IRMA gas analyzer.
Factory calibration lost/missing <sup>5</sup>	Indicates that the factory calibration is lost or missing in the IRMA gas analyzer.	If persistent, replace the IRMA gas analyzer.

#### 14.3.16 Technical specification

##### General specifications

Description	Extremely compact infrared mainstream multigas probe available in two parameter configurations.
Dimensions (W×D×H)	38 x 37 x 34 mm (1.49" × 1.45" × 1.34")
Cable length	2.5 m ±0.1 m
Weight	< 25 g (cable excluded)
Operating temperature	IRMA CO2: 0–40°C , 32–104°F IRMA AX+: 10–40°C , 50–104°F
Storage temperature	-40–75°C, -40–167°F
Operating humidity	< 40 hPa H <sub>2</sub> O (non-condensing) (95 %RH at 30 °C)
Storage humidity	5–100% RH (condensing) <sup>6</sup> , at a water vapor partial pressure not exceeding 74 hPa (100 %RH at 40 °C).
Operating atmospheric pressure	525–1200 hPa (525 hPa corresponding to an altitude of 5 211 m / 17 100 feet)

<sup>4</sup> Optional message text; Unspecified Accuracy

<sup>5</sup> Optional message text; Gas Sensor Error

<sup>6</sup> After being in a condensing atmosphere, the unit shall be stored for more than 24 h in an environment equivalent to the operating humidity.

Storage atmospheric pressure	500 to 1200 hPa (500 hPa corresponding to an altitude of 5 572 m / 18 280 feet)
Mechanical strength	Withstands repeated 1.8 m drops on a hard surface. Complies with requirements for shock and vibration for professional transportation according to EN ISO 80601-2-55:2011 and EN 60601-1-12:2015.
Power supply	IRMA CO2: 4.5-5.5 VDC, max 1.0 W IRMA AX+: 4.5-5.5 VDC, max 1.4 W (power on surge @ 5 V less than 350 mA during 200 ms)
Recovery time after defibrillator test	Unaffected
Drift of measurement accuracy	No drift
Surface temperature (at ambient temp. 23°C)	IRMA CO2: Max 39°C / 102°F IRMA AX+: Max 46°C / 115°F
Interface	Modified RS-232 serial interface operating at 9600 bps.
Protection against ingress of solid foreign objects and water	IP44 - protection against solid objects over 1 mm and water splashed from all directions.
Airway adapters	Disposable adult/pediatric: <ul style="list-style-type: none"> <li>- Adds less than 6 ml deadspace.</li> <li>- Pressure drop less than 0.3 cm H<sub>2</sub>O @ 30 LPM.</li> </ul> Disposable infant: <ul style="list-style-type: none"> <li>- Adds less than 1 ml deadspace.</li> <li>- Pressure drop less than 1.3 cm H<sub>2</sub>O @ 10 LPM.</li> </ul> (Infant Airway Adapter recommended for Tracheal Tube ID size ≤ 4 mm)
Compliance	MDD 93/42/EEC EN ISO 80601-2-55:2011 EN 60601-1:2006 + A1 2013 EN 60601-1-2:2007 EN ISO 5356-1:2004 EN 60601-1-12:2015 (IRMA CO2)
<b>Data output</b>	
Breath detection	Adaptive threshold, minimum 1 vol% change in CO <sub>2</sub> concentration.
Respiration rate <sup>7</sup>	0–150 ±1 bpm. The respiration rate is displayed after three breaths and the average value is updated every breath.

Fi and ET <sup>7</sup>	<p>IRMA CO<sub>2</sub>: CO<sub>2</sub>  IRMA AX+: CO<sub>2</sub>, N<sub>2</sub>O, primary and secondary agents (HAL, ISO, ENF, SEV, DES)  Fi and ET are displayed after one breath and have a continually updated breath average.</p> <p>The following methods are used to calculate end-tidal (ET) values:</p> <ul style="list-style-type: none"> <li>- CO<sub>2</sub>: The highest concentration of CO<sub>2</sub> during one breathing cycle with a weight function applied to favor values closer to the end of the cycle.</li> <li>- N<sub>2</sub>O and anesthetic agents: The momentary gas concentration at the time point where ETCO<sub>2</sub> is detected.</li> </ul> <p>ET-values for anaesthetic agents and N<sub>2</sub>O (IRMA AX+) will typically decrease below nominal value when respiratory rate exceeds 80 bpm.  The maximum decrease is described by the formula <math>ET = 80 \cdot ET_{nom} / RR</math>.  ETCO<sub>2</sub> will be within specification for all respiratory rates up to 150 bpm (IRMA CO<sub>2</sub> and IRMA AX+)<sup>8</sup></p>
Automatic agent identification	IRMA AX+: Primary and secondary agent.

### Gas analyzer

Probe	2-9 channel NDIR type gas analyzer measuring at 4–10 μm. Data acquisition rate 10 kHz (sample rate 20 Hz / channel). Pressure, temperature and full spectral interference correction.
Calibration	Zeroing recommended when changing Airway adapter (IRMA AX+) No span calibration required for the IR bench.
Warm-up time	IRMA CO <sub>2</sub> : < 10 seconds (full accuracy) IRMA AX+: < 20 seconds (agent identification enabled and full accuracy)
Warm up time after storage at –40° C (IRMA CO <sub>2</sub> only)	A warm up period of 15 minutes <sup>9</sup> is required for IRMA CO <sub>2</sub> to fulfill the accuracy specification if immediately put into use in 20° C ambient temperature after being stored at –40°C.
Rise time <sup>10</sup> (@ 10 l/min)	CO <sub>2</sub> ≤ 90 ms N <sub>2</sub> O ≤ 300 ms HAL, ISO, ENF, SEV, DES ≤ 300 ms

<sup>7</sup> Measured at I/E ratio 1:1 using breath simulator according to EN ISO 80601-2-55 fig. 201.101.

<sup>8</sup> EtCO<sub>2</sub> accuracy specification according to section 0 applies for respiratory rates >125 bpm for IRMA AX+

<sup>9</sup> A "Change Adapter" message may appear if immediately put into use after being stored at -40°C; the message can be ignored if automatically restored after the warm up period.

<sup>10</sup> Measured @ 10 l/min with gas concentration steps corresponding to 30% of total measuring range for each gas.

Primary agent threshold	0.15 vol%. When an agent is identified, concentrations will be reported even below 0.15 vol% as long as apnea is not detected.
Secondary agent threshold	0.2 vol% + 10% of total agent concentration
Agent identification time	< 20 seconds. (Typically < 10 seconds)
Total system response time <sup>11</sup>	< 1 second

### Accuracy – standard conditions

The following accuracy specifications are valid with no drift for dry single gases at  $22 \pm 5$  °C and  $1013 \pm 40$  hPa

Gas	Range	Accuracy
CO <sub>2</sub>	0 to 15 vol%	$\pm(0.2 \text{ vol}\% + 2\% \text{ of reading})$
	15 to 25 vol%	Unspecified
N <sub>2</sub> O	0 to 100 vol%	$\pm(2 \text{ vol}\% + 2\% \text{ of reading})$
HAL, ISO, ENF	0 to 8 vol%	$\pm(0.15 \text{ vol}\% + 5\% \text{ of reading})$
	8 to 25 vol%	Unspecified
SEV	0 to 10 vol%	$\pm(0.15 \text{ vol}\% + 5\% \text{ of reading})$
	10 to 25 vol%	Unspecified
DES	0 to 22 vol%	$\pm(0.15 \text{ vol}\% + 5\% \text{ of reading})$
	22 to 25 vol%	Unspecified

### Accuracy – all conditions

The following accuracy specifications are valid with no drift for all specified environmental conditions except for interference specified in the table “Interfering gas effects” and the section “Effects from water vapor partial pressure on gas readings” below.

Gas	Accuracy
CO <sub>2</sub>	$\pm(0.3 \text{ kPa} + 4\% \text{ of reading})$
N <sub>2</sub> O	$\pm(2 \text{ kPa} + 5\% \text{ of reading})$
Agents <sup>12</sup>	$\pm(0.2 \text{ kPa} + 10\% \text{ of reading})$

<sup>11</sup> Measured according to EN ISO 80601-2-55.

<sup>12</sup> The accuracy specification for IRMA AX+ is not valid if more than two agents are present in the gas mixture. If more than two agents are present, an alarm will be set.

### Gas concentration conversion

Gas concentration is reported in units of volume percent. The concentration is defined as:

$$\%gas = \frac{(Partial\ pressure\ of\ gas\ component)}{(Total\ pressure\ of\ gas\ mixture)} * 100$$

The total pressure of the gas mixture is estimated by measuring the actual atmospheric pressure in the IRMA probe.

### Effects from water vapor partial pressure on gas readings

The effects of water vapor are illustrated by the examples in the following table. The two columns to the right show the relative error in displayed concentrations when adding or removing water vapor from the gas mixture and referencing the measurement to dry gas conditions at actual temperature and pressure (ATPD) or saturated conditions at body temperature (BTPS).

Temp [C]	RH [%]	P [hPa]	H <sub>2</sub> O part.pres. [hPa]	err <sub>rel</sub> [%]	err <sub>rel</sub> ATPD [%]	err <sub>rel</sub> [%] BTPS
10	20	1013	2	0	-0.2	+6.0
20	20	1013	5	0	-0.5	+5.7
25	0	1013	0 (ATPD)	0	0	+6.2
25	23	1013	7.3	0	-0.7	+5.5
25	50	1013	16	0	-1.6	+4.6
30	80	1013	42	0	-4.1	+2.0
37	100	1013	63 (BTPS)	0	-6.2	0
37	100	700	63	0	-9.0	-2.8

The table illustrates that the gas concentrations in the alveoli, where the breathing gas is saturated with water vapor at body temperature (BTPS), are 6.2% lower than the corresponding concentrations in the same gas mixture after removal of all water vapor (ATPD).

**Interfering gas effects**

Gas or vapor	Gas level	CO <sub>2</sub>		Agents	N <sub>2</sub> O
		IRMA CO <sub>2</sub>	IRMA AX+		
N <sub>2</sub> O <sup>4)</sup>	60 vol%	- 1 & 2)	- 1 & 2)	- 1)	- 1)
HAL <sup>4)</sup>	4 vol%	- 1)	- 1)	- 1)	- 1)
ENF, ISO, SEV <sup>4)</sup>	5 vol%	+8% of reading <sup>3)</sup>	- 1)	- 1)	- 1)
DES <sup>4)</sup>	15 vol%	+12% of reading <sup>3)</sup>	- 1)	- 1)	- 1)
Xe (Xenon) <sup>4)</sup>	80 vol%	-10% of reading <sup>3)</sup>		- 1)	- 1)
He (Helium) <sup>4)</sup>	50 vol%	-6% of reading <sup>3)</sup>		- 1)	- 1)
Metered dose inhaler propellants <sup>4)</sup>	Not for use with metered dose inhaler propellants				
C <sub>2</sub> H <sub>5</sub> OH (Ethanol) <sup>4)</sup>	0.3 vol%	- 1)	- 1)	- 1)	- 1)
C <sub>3</sub> H <sub>7</sub> OH (Isopropanol) <sup>4)</sup>	0.5 vol%	- 1)	- 1)	- 1)	- 1)
CH <sub>3</sub> COCH <sub>3</sub> (Acetone) <sup>4)</sup>	1 vol%	- 1)	- 1)	- 1)	- 1)
CH <sub>4</sub> (Methane) <sup>4)</sup>	3 vol%	- 1)	- 1)	- 1)	- 1)
CO (Carbon monoxide) <sup>5)</sup>	1 vol%	- 1)	- 1)	- 1)	- 1)
NO (Nitrogen monoxide) <sup>5)</sup>	0.02 vol%	- 1)	- 1)	- 1)	- 1)
O <sub>2</sub> <sup>5)</sup>	100 vol%	- 1 & 2)	- 1 & 2)	- 1)	- 1)

**Note 1:** Negligible interference, effect included in the specification “Accuracy, all conditions” above.

**Note 2:** For probes not measuring N<sub>2</sub>O and/or O<sub>2</sub> the concentrations shall be set from host. (IRMA CO<sub>2</sub> measures neither N<sub>2</sub>O nor O<sub>2</sub>, IRMA AX+ does not measure O<sub>2</sub>.)

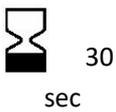
**Note 3:** Interference at indicated gas level. For example, 50 vol% Helium typically decreases the CO<sub>2</sub> readings by 6%. This means that if measuring on a mixture containing 5.0 vol% CO<sub>2</sub> and 50 vol% Helium, the measured CO<sub>2</sub> concentration will typically be  $(1-0.06) * 5.0 \text{ vol\%} = 4.7 \text{ vol\% CO}_2$ .

**Note 4:** According to the EN ISO 80601-2-55:2011 standard.

**Note 5:** In addition to the EN ISO 80601-2-55:2011 standard.

**Symbols used – the complete list**

<b>Symbol</b>	<b>Title</b>	<b>Explanation</b>
	Follow instructions for use	Follow IRMA User's Guide and user documentation for the medical backboard device
	Consult instructions for use	IRMA Airway Adapters: Consult IRMA User's Guide.
	Catalog number (Masimo)	4429 = IRMA CO2 (CO2) 4430 = IRMA AX+ (CO2, N2O, 5 AA, AA ID) 4495 = IRMA CO2 (CO2) 200101 = IRMA CO2 (CO2) 200104 = IRMA CO2 (CO2) 200105 = IRMA CO2 (CO2) 200107 = IRMA CO2 LEMO (CO2) 200601 = IRMA AX+ (CO2, N2O, 5 AA, AA ID) 200604 = IRMA AX+ (CO2, N2O, 5 AA, AA ID) 200607 = IRMA AX+ LEMO (CO2, N2O, 5 AA, AA ID) 989803203041 = IRMA CO2 (CO2)
	Serial number	
	Batch code	
	Use by date [YYYY-MM-DD]	Indicates that the device should not be taken into operation after the date accompanying the symbol.
	Storage ambient temperature limitation	Indicates that the device should not be stored in ambient temperature conditions outside the specified range.
	Storage atmospheric pressure limitation	Indicates that the device should not be stored in atmospheric pressure conditions outside the specified range.
	Storage ambient humidity limitation	Indicates that the device should not be stored in ambient humidity conditions outside the specified range.
	Do not re-use	Intended for single patient use (IRMA Airway Adapters)

Symbol	Title	Explanation
	Waste Electrical and Electronic Equipment (WEEE)	Electrical and electric equipment shall be collected and recycled in accordance with (Directive 2002/96/EC)
	Conformité Européenne	Complies with 93/42/EEC Medical Device Directive when connected to medical devices approved by Masimo Sweden AB.
<b>IP44</b>	IP classification indicating degree of protection against ingress of solid foreign objects and water	IP44 - protection against solid objects over 1mm and water splashed from all directions
	Rx only	Caution (U.S.): Federal law restricts this device to sale by or on the order of a physician
	Date of manufacture [YYYY-MM-DD]	
	Manufacturer	
	Zero-point adjustment	Label on IRMA Airway Adapter box indicating recommendation to perform zeroing of IRMA AX+ when changing Airway Adapter. See ch. 14.3.8.
	Time delay before performing zero-point adjustment	Label on IRMA Airway Adapter indicating time delay before performing zeroing of IRMA AX+ when changing Airway Adapter. See ch.14.3.8.

**Other symbols**

Symbol	Title	Explanation
	Class II Equipment	To identify equipment meeting the safety requirements specified for Class II equipment according to IEC 61140
	Defibrillation-proof type BF applied part	To identify a defibrillation-proof type BF applied part complying with IEC 60601-1.

**EMC****Guidance and MASIMO's declaration – electromagnetic immunity – for IRMA probe**

The IRMA gas analyzer is intended for use in the electromagnetic environment specified below. The customer or the user of the IRMA probe should assure that it is used in such an environment.

<b>Emissions test</b>	<b>Compliance</b>	<b>Electromagnetic environment – guidance</b>
RF emissions CISPR 11	Group 1	The IRMA gas analyzer 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 B	The IRMA gas analyzer is suitable for use in all establishments including domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.

The IRMA gas analyzer is intended for use in the electromagnetic environment specified below. The customer or the user of the IRMA probe should assure that it is used in such an environment.

<b>Immunity test</b>	<b>IEC 60601 test level</b>	<b>Compliance level</b>	<b>Electromagnetic environment – guidance</b>
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 %.
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.

### Guidance and MASIMO's declaration – electromagnetic immunity – for IRMA probe

The IRMA gas analyzer is intended for use in the electromagnetic environment specified below. The customer or the user of the IRMA probe 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 80% AM @ 2 Hz 150 kHz – 80 MHz	3 Vrms	Portable and mobile RF communications equipment should be used no closer to any part of the IRMA gas analyzer, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. <b>Recommended separation distance</b> $d = 1,17\sqrt{P}$
Radiated RF IEC 61000-4-3	3 V/m 80% AM @ 2 Hz 80 MHz – 2,5 GHz	3 V/m	$d = 1,17\sqrt{P}$ 80 MHz to 800 MHz $d = 2,33\sqrt{P}$ 800 MHz to 2,5 GHz
Only IRMA CO2	20 V/m 80% AM @ 1 kHz 80 MHz – 2,5 GHz	20 V/m	

$$d = 0,18\sqrt{P} \quad 80 \text{ MHz to } 800 \text{ MHz}$$

$$d = 0,35\sqrt{P} \quad 800 \text{ MHz to } 2,5 \text{ GHz}$$

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).

Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,<sup>a</sup> should be less than the compliance level in each frequency range.<sup>b</sup>

Interference may occur in the vicinity of equipment marked with the following symbol:



**Note 1:** At 80 MHz and 800 MHz, the higher frequency range applies.

**Note 2:** These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

<sup>a</sup> 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 IRMA probe is used exceeds the applicable RF compliance level above, the IRMA probe should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the IRMA gas analyzer.

<sup>b</sup> Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 10 V/m.

### Recommended separation distances between portable and mobile RF communications equipment and the IRMA gas analyzer

The IRMA gas analyzer is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the IRMA probe can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the IRMA probe as recommended below, according to the maximum output power of the communications equipment.

#### IRMA AX+

Rated maximum output power of transmitter [W]	Separation distance according to frequency of transmitter [m]		
	150 kHz to 80 MHz	80 MHz to 800 MHz	800 MHz to 2.5 GHz
	$d = 1,17\sqrt{P}$	$d = 1,17\sqrt{P}$	$d = 2,33\sqrt{P}$
0.01	0,12	0,12	0,23
0.1	0,37	0,37	0,74
1	1,17	1,17	2,33
10	3,70	3,70	7,37
100	11,70	11,70	23,30

#### IRMA CO2

Rated maximum output power of transmitter [W]	Separation distance according to frequency of transmitter [m]		
	150 kHz to 80 MHz	80 MHz to 800 MHz	800 MHz to 2.5 GHz
	$d = 1,17\sqrt{P}$	$d = 0,18\sqrt{P}$	$d = 0,35\sqrt{P}$
0.01	0,12	0,02	0,04
0.1	0,37	0,06	0,11
1	1,17	0,18	0,35
10	3,70	0,57	1,11
100	11,70	1,80	3,50

For transmitters rated at a maximum output power not listed above, the recommended separation distance  $d$  in meters (m) can be estimated 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 1:** At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

**Note 2:** These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.



**Warning:** Measurements can be affected by mobile and RF communications equipment. It should be assured that the IRMA probe is used in the electromagnetic environment specified in this manual.

#### 14.3.17 Accessories and consumables

This section contains a list of IRMA related accessories and consumables offered by Masimo Sweden AB. For further information regarding accessories and consumables visit our web site ([www.masimo.com](http://www.masimo.com)).

Product	Description
Calibration Gas Regulator Kit	Gas regulator kit for IRMA.
IRMA Velcro Holder	Holder with Velcro tape for the IRMA gas analyzers
IRMA Airway Adapter, Adult/Pediatric	Adult/Pediatric IRMA Airway Adapter for IRMA CO <sub>2</sub> and IRMA AX+. Box of 25 pcs.
IRMA Airway Adapter, Infant	Infant IRMA Airway Adapter for IRMA CO <sub>2</sub> and IRMA AX+. Box of 10 pcs.

## 14.4 Sidestream Gas Analyzer

### 14.4.1 Intended use

The ISA product family consists of three types of sidestream gas analyzers (ISA CO<sub>2</sub>, ISA AX+ and ISA OR+) and accessories including NomoLine, intended to be connected to other medical backboard devices for monitoring of breath rate and the following breathing gases:

ISA CO<sub>2</sub>: CO<sub>2</sub>

ISA AX+: CO<sub>2</sub>, N<sub>2</sub>O, Halothane, Isoflurane, Enflurane, Sevoflurane and Desflurane

ISA OR+: CO<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>O, Halothane, Isoflurane, Enflurane, Sevoflurane and Desflurane

ISA CO<sub>2</sub>, ISA AX+ and ISA OR+ are intended to be connected to a patient breathing circuit for monitoring of inspired/expired gases during anesthesia, recovery and respiratory care. The intended environment is the operating suite, intensive care unit and patient room. ISA CO<sub>2</sub> is also intended to be used in road ambulances. The intended patient population is adult, pediatric, infant and neonatal patients.

**Note 1:** An ISA sidestream gas analyzer should never be used as the only means of monitoring a patient.

**Note 2:** An ISA sidestream gas analyzer shall only be connected to medical backboard devices approved by Masimo Sweden AB.

**Note 3:** See also NomoLine Family Directions For Use.

### 14.4.2 Symbols

Symbol	Title	Explanation
	Follow instructions for use	Follow ISA User's Guide and user documentation for the medical backboard device
	Consult instructions for use	Consult NomoLine Family Directions For Use
	Use by date [YYYY-MM-DD]	Indicates that the device should not be taken into operation after the date accompanying the symbol
	Do not re-use	Single patient use products
	Biohazardous waste	NomoLine Family sampling lines shall be disposed as biohazardous waste

<b>IPX4</b>	IP classification indicating degree of protection against ingress of water	IPX4 - protection against water splashed from all directions
	CO2	ISA equipped to measure CO2
	Multigas (AX+ or OR+)	ISA equipped to measure multiple gases
	Gas Inlet	Gas inlet for connecting the NomoLine Family sampling lines
	Gas Outlet (evac)	Evacuation outlet
	Defibrillation-proof type BF applied part	The applied part of ISA is the NomoLine Family sampling line

For a complete list of symbols and complete specifications, please refer to section 14.4.16 Technical specification (English only).

#### 14.4.3 Technical specification

<b>Operating temperature</b>	ISA CO <sub>2</sub> : 0 to 50 °C (32 to 122 °F) ISA OR+/AX+: 5 to 50 °C (41 to 122 °F)
<b>Operating atmospheric pressure</b>	525 to 1200 hPa (corresponding to a max altitude of 5211 m / 17100 feet)
<b>Respiration rate</b>	0 to 150 ± 1 breaths/min
<b>Warm-up time</b>	ISA CO <sub>2</sub> : < 10 seconds (Concentrations reported and full accuracy) ISA OR+/AX+: < 20 seconds (Concentrations reported, automatic agent identification enabled and full accuracy)
<b>Primary agent threshold (ISA OR+/AX+)</b>	0.15 vol%. When an agent is identified, concentrations will be reported even below 0.15 vol%
<b>Secondary agent threshold (ISA OR+/AX+)</b>	0.2 vol% + 10% of total agent concentration
<b>Agent identification time (ISA OR+/AX+)</b>	< 20 seconds (typically < 10 seconds)

<b>Total system response time</b>	<u>ISA CO<sub>2</sub></u> < 3 seconds <u>ISA OR+/AX+</u> < 4 seconds (with 2 m NomoLine Airway Adapter Set sampling line)
<b>Sampling flow rate</b>	50 ± 10 sml/min

#### Accuracy – standard conditions

The following accuracy specifications are valid for dry single gases at 22 ± 5 °C and 1013 ± 40 hPa:

Gas	Range	Accuracy
CO <sub>2</sub>	0 to 15 vol%	±(0.2 vol% + 2% of reading)
N <sub>2</sub> O	0 to 100 vol%	±(2 vol% + 2% of reading)
HAL, ENF, ISO	0 to 8 vol%	±(0.15 vol% + 5% of reading)
SEV	0 to 10 vol%	±(0.15 vol% + 5% of reading)
DES	0 to 22 vol%	±(0.15 vol% + 5% of reading)
O <sub>2</sub>	0 to 100 vol%	±(1 vol% + 2% of reading)

For a complete list of symbols and complete specifications, see section 14.4.16 Technical specification (English only).

#### 14.4.4 NomoLine Family sampling lines

ISA samples gas from the respiratory circuit through the NomoLine Family sampling line at a rate of 50 sml/min, making measurements of CO<sub>2</sub> possible for adult, pediatric, infant and neonatal patients.

NomoLine sampling lines include nasal and nasal/oral cannulas for non-intubated patients with and without supplementary oxygen delivery and airway adapter sets for intubated patients.

The NomoLine Family sampling lines are divided in two application categories:

- NomoLine LH (Low-Humidity) – Single-patient-use sampling lines for short-term applications in low-humidity conditions.
- NomoLine HH (High-Humidity) – Single-patient-use sampling lines for long-term applications in high-humidity conditions.

The NomoLine sampling lines are designed to either collect (LH) or remove (HH) condensed water and incorporate a bacteria filter that protects the gas analyzer from water intrusion and cross contamination.

As long as no sampling line is connected, the ISA gas analyzer remains in a low-power sleep mode. Once the sampling line is connected, the ISA gas analyzer switches to measuring mode and starts delivering gas data.

The NomoLine Family of sampling lines are designed for optimal performance and measurement fidelity when used with the ISA gas analyzers. For instance, when connecting to a respiratory circuit, the Masimo Airway Adapter Sets provides a central gas sampling point thereby minimizing the risk of sampling line occlusion (see below).

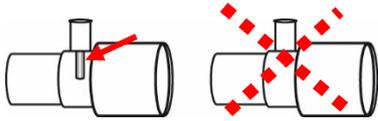


Figure 1. For optimal water handling, always use airway adapter sets with the sampling point in the center of the adapter, as shown to the left above.

**Note:** Using sample tubes or cannulas with larger inner diameter than 1 mm will increase ISA's total system response time.

For ordering information of NomoLine Family sampling lines, cannulas and related consumables, please refer to section 14.4.17 or visit [www.masimo.com](http://www.masimo.com).

#### **NomoLine Family sampling line replacement**

NomoLine Family sampling lines should be replaced according to good clinical practice or when the sampling line gets occluded. Occlusion occurs when water, secretion etc. is aspirated from the respiratory circuit to such extent that ISA cannot maintain the normal 50 sml/min sample flow. This situation is indicated by a red flashing gas inlet connector and an alarm message; Replace the NomoLine and wait until the gas inlet connector switches to green indicating that the ISA gas analyzer is ready for use.

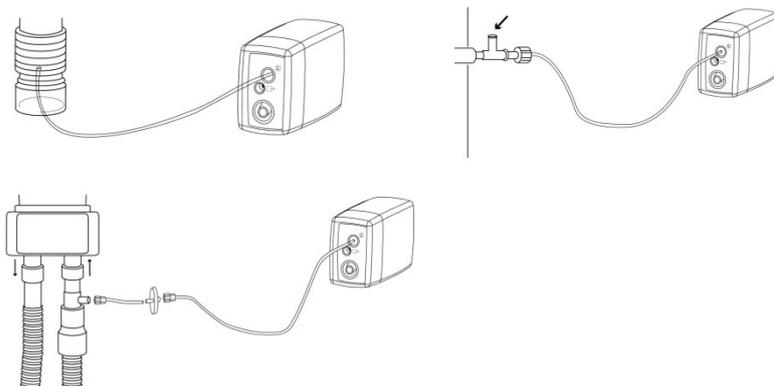
#### **14.4.5 System set-up**

See also User Manual for medical backboard device.

To set up the medical backboard device for gas analysis, follow these steps:

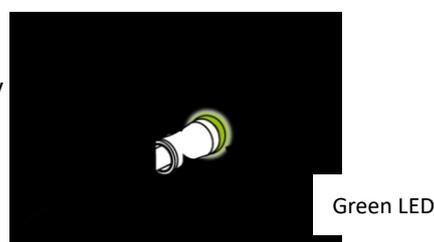
1. Securely mount the ISA analyzer.
2. Connect the ISA analyzer interface cable to the medical backboard. The interface cable connector is used as disconnecting device.
3. Connect a NomoLine Family sampling line to the ISA analyzer input connector.
4. Connect the gas sample exhaust port to a scavenging system or return the gas to the patient circuit to prevent pollution of the operation room when N<sub>2</sub>O and/or anesthetic agents are

being used. Due to the risk of patient cross-infection, always use a bacteria filter<sup>13</sup> on the exhaust port side if sampled gas is intended to be re-breathed.



**Note:** Returning the ISA's exhaust gas to the patient circuit is not allowed in the USA.

5. Power up the medical backboard.
6. A green LED indicates that the ISA analyzer is ready



7. Perform a pre-use check as described in section 14.4.6.

#### 14.4.6 Pre-use check

Before connecting the NomoLine Family sampling line to the breathing circuit, do the following:

1. Connect the sampling line to the ISA gas inlet connector.
2. Check that the gas inlet connector is lit with a steady green light.
3. *For ISA OR+:*  
Check that the O<sub>2</sub> reading on the medical backboard device is correct (21 vol%).
4. Breathe briefly into the sampling line and check that the medical backboard device displays a valid CO<sub>2</sub> waveform and valid values.
5. Occlude the sampling line with a fingertip and wait for 10 seconds.
6. Check that an occlusion alarm is displayed and that the gas inlet connector shows a flashing red light.
7. *If applicable:*  
Perform a tightness check of the patient circuit with the sampling line attached.

1. <sup>13</sup>Masimo Sweden AB recommends Minisart 16596HYK supplied by Sartorius Stedim or equivalent

#### 14.4.7 Leakage check

1. Connect a new NomoLine sampling line with male Luer lock to the ISA gas inlet connector and check that the gas inlet connector shows a steady green light.
2. Connect a short silicon tubing with an inner diameter of 3/32" (2.4 mm) to the NomoLine male Luer.
3. Exhale a long breath into the silicon tubing until the CO<sub>2</sub> concentration is greater than 4.5 vol% or 34 mmHg.
4. Quickly connect the silicon tubing tightly to the exhaust port.
5. Wait 1 minute until the CO<sub>2</sub> concentration has stabilized. Note the value.
6. Wait 1 minute and check that the CO<sub>2</sub> concentration has not decreased more than 0.4 vol% or 3 mmHg. If it has decreased more there is a major leakage in the ISA unit or in the NomoLine. Do not operate the ISA if there is a major leakage in the unit.

#### 14.4.8 Maintenance

Once every year, or whenever gas readings are questionable, perform a leakage check according to section 14.4.7 and verify gas readings with a reference instrument or with calibration gas. Calibration gases shall be handled and disposed of in accordance with local regulations.

#### 14.4.9 Zeroing

The gas analyzer needs from time to time to establish a zero reference level for the gas measurements and the flow. The zero calibration is here referred to as "zeroing".

ISA performs zeroing by switching the gas sampling from the respiratory circuit to ambient air. The automatic zeroing is performed 1 to 3 times per day and takes less than 3 seconds for ISA CO<sub>2</sub> gas analyzers and less than 10 seconds for ISA Multigas analyzers.

During zeroing, if ISA's exhaust gas is returned to the patient circuit, the returned gas level will be different from the gas level at the sampling site.

#### 14.4.10 Alarms

See Appendix C for a complete description of the alarm handling related to the ISA sidestream gas analyzer.

#### 14.4.11 ISA gas inlet connector status indicator

Indication	Status
Steady green light	ISA in operation and OK
Blinking green light	Zeroing in progress
Steady blue light	Anesthetic agent present
Steady red light	ISA sensor error
Blinking red light	Check sampling line

#### 14.4.12 Cleaning

The ISA sidestream gas analyzers may be cleaned using a cloth moistened (not wet) with max 70% ethanol or isopropyl alcohol.

To prevent cleaning liquids and dust from entering the ISA gas analyzer through its sampling gas inlet connector, keep the NomoLine Family sampling line fitted while cleaning the analyzer.



**Warning:** Never sterilize or immerse the ISA sidestream gas analyzer in liquid.

#### 14.4.13 Warnings



The ISA sidestream gas analyzer is intended for use by authorized healthcare professionals only.

Carefully route the sampling line to reduce the risk of patient entanglement or strangulation.

Do not lift the ISA gas analyzer by the sampling line as it could disconnect from the ISA, causing the ISA gas analyzer to fall on the patient.

Dispose NomoLine Family sampling lines in accordance with local regulations for biohazardous waste.

Use only airway T-adapters with the sampling point in the center of the adapter.

Do only use sample lines intended for anesthetic agents if N<sub>2</sub>O and/or anesthetic agents are being used.

Do not use the T-adapter with infants or neonates, as this adds 7 ml dead space to the patient circuit.

Do not use the ISA gas analyzer with metered-dose inhalers or nebulized medications as this may clog the bacteria filter.

---

Since a successful zeroing requires the presence of ambient air (21% O<sub>2</sub> and 0% CO<sub>2</sub>), ensure that the ISA is placed in a well ventilated place. Avoid breathing near the ISA sidestream gas analyzer before or during the zeroing procedure.

---

Never sterilize or immerse the ISA sidestream gas analyzer in liquid.

---

The ISA sidestream gas analyzer is intended only as an adjunct in patient assessment. It must be used in conjunction with other assessments of clinical signs and symptoms.

---

Measurements can be affected by mobile and portable RF communications equipment. Make sure that the ISA sidestream gas analyzer is used in the electromagnetic environment specified in this manual.

---

Replace the sampling line if the sampling line input connector starts flashing red, or the medical backboard device displays a "Check sampling line" message.

---

No modification of this equipment is allowed without authorization of the manufacturer. If this equipment is modified, appropriate inspection and testing must be conducted to ensure continued safe operation.

---

The ISA sidestream gas analyzers are not designed for MRI environments.

---

During MRI scanning, ISA must be placed outside the MRI suite.

---

Use of high frequency electrosurgical equipment in the vicinity of the ISA/medical backboard device may produce interference and cause incorrect measurements.

---

Do not apply negative pressure to remove condensed water from the NomoLine Family sampling line.

---

Too strong positive or negative pressure in the patient circuit might affect the sample flow.

---

Strong scavenging suction pressure might affect the sample flow.

---

Exhaust gases should be returned to the patient circuit or to a scavenging system.

---

Due to the risk of patient cross-infection, always use a bacteria filter on the exhaust port side if sampled gas is intended to be re-breathed.

---

Do not place the ISA gas analyzer in any position that might cause it to fall on the patient.

---

Do not re-use disposable single-patient use NomoLine Family sampling lines due to the risk of cross contamination.

---

Do not sterilize or immerse NomoLine Family sampling lines in liquid.

---

Do not operate the ISA sidestream gas analyzer if the enclosure is damaged.

---

Do not use the NomoLine Adult/Pediatric Airway Adapter Sets for infants/neonates as the adult/pediatric airway adapter adds 6 ml dead space.

Do not use the NomoLine Infant/Neonate Airway Adapter Sets for adults/pediatrics as they may cause excessive flow resistance (0.7 ml dead space).

#### 14.4.14 Cautions

The ISA analyzers should be securely mounted in order to avoid the risk of damage to the ISA.

Do not operate the ISA sidestream gas analyzer outside the specified operating environment.

(US Only) Caution: Federal law restricts this device to sale by or on the order of a physician. For professional use. See instructions for use for full prescribing information, including indications, contraindications, warnings, precautions and adverse events.

#### 14.4.15 Classifications

According to the degree of protection against harmful ingress of water:

- IPX4

According to sterility:

- The ISA system contains no sterile parts.

According to the mode of operation:

- CONTINUOUS OPERATION

According to the degree of protection against electric shock:

- NomoLine Family sampling lines are classified as DEFIBRILLATION-PROOF TYPE BF APPLIED PART

The combination of ISA and medical backboard device shall be considered a ME SYSTEM.

#### 14.4.16 Technical specification

##### General

<b>Description</b>	Compact, low-flow sidestream gas analyzers with integrated pump, zeroing valve and flow controller.	
<b>Dimensions (WxDxH)<sup>14</sup></b>	ISA CO <sub>2</sub> /AX+:	33 x 78 x 49 mm (1.3" x 3.1" x 1.9")
	ISA OR+:	49 x 90 x 100 mm (1.9" x 3.5" x 3.9")
<b>Weight</b>	ISA CO <sub>2</sub> /AX+:	<130 g including cable
	ISA OR+:	<420 g including cable
<b>Operating temperature</b>	ISA CO <sub>2</sub> :	0 to 50 °C (32 to 122 °F)
	ISA OR+/AX+:	5 to 50 °C (41 to 122 °F)
<b>Storage temperature</b>	-40 to 70 °C (-40 to 158 °F)	
<b>Operating humidity</b>	< 4 kPa H <sub>2</sub> O (non-condensing) (95 %RH at 30 °C)	
<b>Storage humidity</b>	5 to 100 %RH (condensing) <sup>15</sup> (100 %RH at 40 °C)	
<b>Operating atmospheric pressure</b>	525 to 1200 hPa (corresponding to a max altitude of 5211 m / 17100 feet)	
<b>Storage atmospheric pressure</b>	200 to 1200 hPa (corresponding to a max altitude of 11760 m / 38 600 feet)	
<b>Ambient CO<sub>2</sub></b>	≤ 800 ppm (0.08 vol%)	
<b>Mechanical robustness</b>	<p>ISA CO<sub>2</sub>:</p> <p>Meets the shock and vibration requirements for transport of EN ISO 80601-2-55:2011 clause 201.15.3.5.101.2 and EN 1789:2007 clause 6.3.4.2.</p> <p>ISA OR+/AX+:</p> <p>Meets the shock and vibration requirements of EN ISO 80601-2-55:2011 clause 201.15.3.5.101.1</p>	
<b>Power supply</b>	<p>4.5 to 5.5 VDC,</p> <p>ISA CO<sub>2</sub>: &lt; 1.4 W (normal op.), &lt; 1.8 W (peak @ 5 VDC)</p> <p>ISA AX+: &lt; 1.6 W (normal op.), &lt; 2.0 W (peak @ 5 VDC)</p> <p>ISA OR+: &lt; 2.0 W (normal op.), &lt; 2.4 W (peak @ 5 VDC)</p>	

<sup>14</sup> Excluding cable, tubing and NomoLine.

<sup>15</sup> The unit shall after condensation be stored for more than 24h in an environment with relative moisture content below 95 %RH (non-condensing).

<b>Recovery time after defibrillator test</b>	Unaffected
<b>Water handling</b>	NomoLine Family sampling lines with proprietary water removal tubing.
<b>Sampling flow rate</b>	50 ± 10 sml/min <sup>16</sup>
<b>Airway Adapters</b>	NomoLine Adult/Pediatric Airway Adapter Sets: ≤ 6 ml dead space NomoLine Infant/Neonate Airway Adapter Sets: : ≤ 0.7 ml dead space
<b>Data output</b>	
<b>Breath detection</b>	Adaptive threshold, minimum 1 vol% change in CO <sub>2</sub> concentration.
<b>Respiration rate<sup>17</sup></b>	0 to 150 ± 1 breaths/min
<b>Fi and ET<sup>4</sup></b>	<p>Fi and ET are displayed after one breath and have a continuously updated breath average.</p> <p>The following methods are used to calculate end-tidal (ET) values:</p> <ul style="list-style-type: none"> <li>- CO<sub>2</sub>: The highest concentration of CO<sub>2</sub> during one breathing cycle with a weight function applied to favor values closer to the end of the cycle.</li> <li>- O<sub>2</sub>: The highest/lowest concentration of O<sub>2</sub> during the expiratory phase (depending on whether ET<sub>O<sub>2</sub></sub> is higher or lower than FiO<sub>2</sub>)</li> <li>- N<sub>2</sub>O and anesthetic agents: The momentary gas concentration at the time point where ET<sub>CO<sub>2</sub></sub> is detected.</li> </ul> <p>ET will typically decrease below nominal value (ET<sub>nom</sub>) when respiration rate (RR) exceeds the RR threshold (RR<sub>th</sub>) according to the following formulas:</p> $ET = ET_{nom} \times \frac{ISA_{CO_2}}{CO_2} \quad ET = ET_{nom} \times (125/RR) \text{ for } RR_{th} > 125$ $ET = ET_{nom} \times \frac{ISA_{OR+/AX+}}{CO_2} \quad ET = ET_{nom} \times \sqrt{(70/RR)} \text{ for } RR_{th} > 70$ $ET = ET_{nom} \times \sqrt{(50/RR)} \text{ for } RR_{th} > 50$ $ET = ET_{nom} \times \sqrt{(35/RR)} \text{ for } RR_{th} > 35$
<b>Automatic agent identification</b>	ISA OR+/AX+: Primary and secondary agent.

<sup>16</sup> Volumetric flow rate of air corrected to standardized conditions of temperature and pressure.

<sup>17</sup> Measured at I/E ratio 1:1 using breath simulator according to EN ISO 80601-2-55 fig. 201.101.

<b>Gas analyzer</b>	
<b>Sensor head</b>	2 to 9 channel NDIR type gas analyzer measuring at 4 to 10 $\mu\text{m}$ . Data acquisition rate 10 kHz (sample rate 20 Hz / channel). O <sub>2</sub> measurements by Servomex's paramagnetic sensor.
<b>Compensations</b>	ISA CO <sub>2</sub> : Automatic compensation for pressure and temperature. Manual compensation for broadening effects on CO <sub>2</sub> . ISA OR+/AX+: Automatic compensation for pressure, temperature and broadening effects on CO <sub>2</sub> .
<b>Calibration</b>	No span calibration is required for the IR bench. An automatic zeroing is performed 1 to 3 times per day.
<b>Warm-up time</b>	ISA CO <sub>2</sub> : < 10 seconds (Concentrations reported and full accuracy) ISA OR+/AX+: < 20 seconds (Concentrations reported, automatic agent identification enabled and full accuracy)
<b>Rise time<sup>18</sup></b>	<u>ISA CO<sub>2</sub></u> CO <sub>2</sub> ≤ 200 ms <u>ISA OR+/AX+</u> CO <sub>2</sub> ≤ 300 ms N <sub>2</sub> O, O <sub>2</sub> , ENF, ISO, SEV, DES ≤ 400 ms HAL ≤ 500 ms
<b>Primary agent threshold (ISA OR+/AX+)</b>	0.15 vol%. When an agent is identified, concentrations will be reported even below 0.15 vol%
<b>Secondary agent threshold (ISA OR+/AX+)</b>	0.2 vol% + 10% of total agent concentration
<b>Agent identification time (ISA OR+/AX+)</b>	< 20 seconds (typically < 10 seconds)
<b>Total system response time<sup>19</sup></b>	<u>ISA CO<sub>2</sub></u> < 3 seconds <u>ISA OR+/AX+</u> < 4 seconds (with 2 m NomoLine Airway Adapter Set sampling line)

<sup>18</sup> Measured according to EN ISO 80601-2-55.

<sup>19</sup> Measured according to EN ISO 80601-2-55.

**Accuracy – standard conditions**

The following accuracy specifications are valid with no drift for dry single gases at  $22 \pm 5$  °C and  $1013 \pm 40$  hPa:

Gas	Range <sup>20</sup>	Accuracy
CO <sub>2</sub>	0 to 15 vol%	$\pm(0.2 \text{ vol}\% + 2\% \text{ of reading})$
	15 to 25 vol%	Unspecified
N <sub>2</sub> O	0 to 100 vol%	$\pm(2 \text{ vol}\% + 2\% \text{ of reading})$
HAL, ENF, ISO	0 to 8 vol%	$\pm(0.15 \text{ vol}\% + 5\% \text{ of reading})$
	8 to 25 vol%	Unspecified
SEV	0 to 10 vol%	$\pm(0.15 \text{ vol}\% + 5\% \text{ of reading})$
	10 to 25 vol%	Unspecified
DES	0 to 22 vol%	$\pm(0.15 \text{ vol}\% + 5\% \text{ of reading})$
	22 to 25 vol%	Unspecified
O <sub>2</sub>	0 to 100 vol%	$\pm(1 \text{ vol}\% + 2\% \text{ of reading})$

**Accuracy – all conditions**

The following accuracy specifications are valid with no drift for all specified environmental conditions, except for interference from water vapor in the below section “Effects from water vapor partial pressure on gas readings”.

Gas	Accuracy
CO <sub>2</sub>	$\pm(0.3 \text{ kPa} + 4\% \text{ of reading})$
N <sub>2</sub> O	$\pm(2 \text{ kPa} + 5\% \text{ of reading})$
Agents <sup>21</sup>	$\pm(0.2 \text{ kPa} + 10\% \text{ of reading})$
O <sub>2</sub>	$\pm(2 \text{ kPa} + 2\% \text{ of reading})$

**Effects from water vapor partial pressure on gas readings**

When the breathing gas flows through the sampling line, the gas temperature will adapt to the ambient temperature before reaching the gas analyzer. The measurement of all gases will always show the actual partial pressure at the current humidity level in the gas sample. As the NOMO section removes all condensed water, no water will reach the ISA gas analyzer. However at an ambient temperature of 37 °C and a breathing gas with a relative humidity of 95% the gas reading will typically be 6% lower than corresponding partial pressure after removal of all water.

<sup>20</sup> All gas concentrations are reported in units of volume percent and may be translated into mmHg or kPa by using the reported atmospheric pressure.

<sup>21</sup> The accuracy specification is not valid if more than two agents are present in the gas mixture. If more than two agents are present, an alarm will be set.

**Interfering gas and vapor effects**

Gas or vapor	Gas level	CO <sub>2</sub>		Agents	N <sub>2</sub> O
		ISA CO <sub>2</sub>	ISA AX+ ISA OR+		
N <sub>2</sub> O <sup>4)</sup>	60 vol%	– <sup>2)</sup>	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>
HAL <sup>4)</sup>	4 vol%	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>
ENF, ISO, SEV <sup>4)</sup>	5 vol%	+8% of reading <sup>3)</sup>	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>
DES <sup>4)</sup>	15 vol%	+12% of reading <sup>3)</sup>	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>
Xe (Xenon) <sup>4)</sup>	80 vol%	–10% of reading <sup>3)</sup>		– <sup>1)</sup>	– <sup>1)</sup>
He (Helium) <sup>4)</sup>	50 vol%	–6% of reading <sup>3)</sup>		– <sup>1)</sup>	– <sup>1)</sup>
Metered dose inhaler propellants <sup>4)</sup>	Not for use with metered dose inhaler propellants				
C <sub>2</sub> H <sub>5</sub> OH (Ethanol) <sup>4)</sup>	0.3 vol%	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>
C <sub>3</sub> H <sub>7</sub> OH (Isopropanol) <sup>4)</sup>	0.5 vol%	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>
CH <sub>3</sub> COCH <sub>3</sub> (Acetone) <sup>4)</sup>	1 vol%	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>
CH <sub>4</sub> (Methane) <sup>4)</sup>	3 vol%	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>
CO (Carbon monoxide) <sup>5)</sup>	1 vol%	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>
NO (Nitrogen monoxide) <sup>5)</sup>	0.02 vol%	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>	– <sup>1)</sup>
O <sub>2</sub> <sup>5)</sup>	100 vol%	– <sup>2)</sup>	– <sup>2)</sup>	– <sup>1)</sup>	– <sup>1)</sup>

**Note 1:** Negligible interference, effect included in the specification “Accuracy, all conditions” above.

**Note 2:** Negligible interference with N<sub>2</sub>O / O<sub>2</sub> concentrations correctly set, effect included in the specification “Accuracy, all conditions” above.

**Note 3:** Interference at indicated gas level. For example, 50 vol% Helium typically decreases the CO<sub>2</sub> readings by 6%. This means that if measuring on a mixture containing 5.0 vol% CO<sub>2</sub> and 50 vol% Helium, the actual measured CO<sub>2</sub> concentration will typically be (1-0.06) \* 5.0 vol% = 4.7 vol% CO<sub>2</sub>.

**Note 4:** According to the EN ISO 80601-2-55:2011 standard.

**Note 5:** In addition to the EN ISO 80601-2-55:2011 standard.

**Symbols used – the complete list**

Symbol	Title	Explanation
	Follow instructions for use	Consult ISA User's Guide and user documentation for the medical backboard device.
	Consult instructions for use	Consult NomoLine Family Directions For Use
	Catalog number (Masimo)	4494 = ISA CO2 (CO2) 800101 = ISA CO2 (CO2) 800106 = ISA CO2 ROOT (CO2) 800107 = ISA CO2 LEMO (CO2) 800601 = ISA AX+ (CO2, N2O, 5 AA, AA ID) 800606 = ISA AX+ ROOT (CO2, N2O, 5 AA, AA ID) 800607 = ISA AX+ LEMO (CO2, N2O, 5 AA, AA ID) 800401 = ISA OR+ (CO2, O2, N2O, 5 AA, AA ID) 800406 = ISA OR+ ROOT (CO2, O2, N2O, 5 AA, AA ID) 800407 = ISA OR+ LEMO (CO2, O2, N2O, 5 AA, AA ID) 989803203031 = ISA CO2 (CO2)
	Serial number	
	Batch code	
	Date of manufacture [YYYY-MM-DD]	
	Use by date [YYYY-MM-DD]	Indicates that the device should not be taken into operation after the date accompanying the symbol.
	Storage ambient temperature limitation	Indicates that the device should not be stored in ambient temperature conditions outside the specified range.
	Storage atmospheric pressure limitation	Indicates that the device should not be stored in atmospheric pressure conditions outside the specified range.
	Storage ambient humidity limitation	Indicates that the device should not be stored in ambient humidity conditions outside the specified range.
	Biohazardous waste	NomoLine Family sampling lines shall be disposed as biohazardous waste
	Do not re-use	Single patient use products

Symbol	Title	Explanation
	For EU only: Waste Electrical and Electronic Equipment (WEEE)	For EU only: Electrical and electric equipment shall be collected and recycled in accordance with (Directive 2002/96/EC)
	Conformité Européenne	Complies with 93/42/EEC Medical Device Directive when connected to medical devices approved by Masimo Sweden AB.
	ETL Listing Mark	Conforms to ANSI/AAMI ES60601-1:2005 Cert. to CAN/CSA-C22.2 No.60601.1:2008.
<b>IPX4</b>	IP classification indicating degree of protection against ingress of water	IPX4 - protection against water splashed from all directions
	Rx only	(US Only) Caution: Federal law restricts this device to sale by or on the order of a physician.
	CO <sub>2</sub>	ISA equipped to measure CO <sub>2</sub>
	Multigas (AX+ or OR+)	ISA equipped to measure multiple gases
	Gas Inlet	Gas inlet for connecting the NomoLine Family sampling lines
	Gas Outlet	Evacuation outlet
	Defibrillation-proof type BF applied part	The applied part of ISA is the NomoLine Family sampling line
	Patient body weight range	The body weight range of the intended patient category
	Number of units	
	Manufacturer	

**Other symbols**

<b>Symbol</b>	<b>Title</b>	<b>Explanation</b>
	Class II Equipment	To identify equipment meeting the safety requirements specified for Class II equipment according to IEC 61140

## Electromagnetic compatibility (EMC)

### Electromagnetic emissions

This section constitutes the guidance and Masimo Sweden AB's declaration regarding electromagnetic emissions for the ISA gas analyzers.

ISA gas analyzers are intended for use in the electromagnetic environment specified in the table below. Customers and end users of ISA gas analyzers should assure that they are used in such an environment.

Emissions test	Compliance	Electromagnetic environment – guidance
RF emissions CISPR 11	Group 1	The ISA sensor 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 B	The ISA sensor is suitable for use in all establishments including domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.

### Electromagnetic immunity

This section constitutes the guidance and Masimo Sweden AB's declaration regarding electromagnetic immunity for the ISA gas analyzers.

ISA gas analyzers are intended for use in the electromagnetic environment specified below. Customers or end users of ISA gas analyzers should assure that they are 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 %.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	30 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment – guidance
Conducted RF IEC 61000-4-6	3 Vrms 80%AM@2Hz 150 kHz – 80 MHz	10 Vrms	<p>Portable and mobile RF communications equipment should be used no closer to any part of the ISA gas analyzer, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.</p> <p><b>Recommended separation distance:</b></p> $d = 0,35\sqrt{P}$
Radiated RF IEC 61000-4-3	3 V/m 80%AM@2Hz 80 MHz – 2,5 GHz	3 V/m	$d = 1,17\sqrt{P} \quad 80 \text{ MHz to } 800 \text{ MHz}$ $d = 2,33\sqrt{P} \quad 800 \text{ MHz to } 2,5 \text{ GHz}$
Only ISA CO2	20 V/m 80%AM@1kHz 80 MHz – 2,5 GHz	20 V/m	$d = 0,18\sqrt{P} \quad 80 \text{ MHz to } 800 \text{ MHz}$ $d = 0,35\sqrt{P} \quad 800 \text{ MHz to } 2,5 \text{ GHz}$ <p>where <math>P</math> is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and <math>d</math> is the recommended separation distance in meters (m).</p>

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment – guidance
			<p>Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,<sup>a</sup> should be less than the compliance level in each frequency range.<sup>b</sup> Interference may occur in the vicinity of equipment marked with the following symbol:</p> 

**Note:** *U<sub>T</sub>* is the a.c. mains voltage prior to application of the test level.

**Note 1:** At 80 MHz and 800 MHz, the higher frequency range applies.

**Note 2:** These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

<sup>a</sup> 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 ISA is used exceeds the applicable RF compliance level above, ISA should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating ISA.

<sup>b</sup> Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 10 V/m.

### Separation distance to RF communications equipment

In this section the recommended separation distances between portable and mobile RF communications equipment and the ISA gas analyzers are specified.

ISA gas analyzers are intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of ISA gas analyzers can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the ISA gas analyzer as recommended below, according to the maximum output power of the communications equipment.

**ISA CO2**

Rated maximum output power of transmitter [W]	Separation distance according to frequency of transmitter [m]		
	150 kHz to 80 MHz	80 MHz to 800 MHz	800 MHz to 2.5 GHz
	$d = 0.35\sqrt{P}$	$d = 0.18\sqrt{P}$	$d = 0.35\sqrt{P}$
0.01	0.04	0.02	0.04
0.1	0.11	0.06	0.11
1	0.35	0.18	0.35
10	1.11	0.57	1.11
100	3.50	1.80	3.50

**ISA AX+, ISA OR+**

Rated maximum output power of transmitter [W]	Separation distance according to frequency of transmitter [m]		
	150 kHz to 80 MHz	80 MHz to 800 MHz	800 MHz to 2.5 GHz
	$d = 0.35\sqrt{P}$	$d = 1.17\sqrt{P}$	$d = 2.33\sqrt{P}$
0.01	0.04	0.12	0.23
0.1	0.11	0.37	0.74
1	0.35	1.17	2.33
10	1.11	3.70	7.37
100	3.50	11.70	23.30

For transmitters rated at a maximum output power not listed above, the recommended separation distance  $d$  in meters (m) can be estimated 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 1:** At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

**Note 2:** These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.



**Warning:** Measurements can be affected by mobile and portable RF communications equipment. Make sure that the ISA gas analyzer is used in the electromagnetic environment specified in this manual.

#### 14.4.17 Accessories and consumables

This section contains a list of ISA related accessories and consumables offered by Masimo Sweden AB. For further information regarding accessories and consumables visit our web site ([www.masimo.com](http://www.masimo.com)).

Product	Description
Calibration Gas Regulator Kit	Gas regulator kit for ISA.
ISA Analyzer Clamp Adapter	Adapter for mounting a gas analyzer to a standard clamp or ISA Modura Holder.
ISA Analyzer Modura Holder	Adapter for mounting a gas analyzer to a standard rail clamp.
NomoLine Low Humidity Cannulas and Airway Adapters	Refer to Directions for use, NomoLine Cannulas and Airway Adapter Sets for details.
NomoLine High Humidity Cannulas and Airway Adapters	Refer to Directions for use, NomoLine Cannulas and Airway Adapter Sets for details.
ISA Gas Exhaust Kit	Kit that provides connection of the gas exhaust from ISA to a scavenging system.

## 14.5 CO2 Setup

Turn knob to move cursor to the area of CO2 parameters, Press button to enter setting [CO2 Setup] menu.



CO2 setup menu

### [Apnea time]

The Monitor will alarm if the patient has stopped breathing for longer than the preset apnea time.  
Setup for: 20s, 25s, 30s, 35s, 40s, 45s, 50s, 55s, 60s

### [Operating Mode]

CO2 module can setup for "Measure" or "standby"

Measure: CO2 module can conduct normal measurement and zeroing etc.

On standby: CO2 module is not in use; CO2 measurement, zeroing, calibrating, etc. is not possible.

### [O2 Compen]

Setup for low, medium, high. Default value is low.

### [N2O Compen]

Setup for ON, OFF. Default value is off.

### [Unit]

Use for EtCO2 and FICO2 parameter display. Can setup units to mmHg, kPa, %. Default value is mmHg.

**[Waveform Speed]**

Use for adjusting speed of CO2 waveform. Can setup for 6.25mm/s, 12.5mm/s, 25mm/s.

**[Waveform Mode]**

Draw: The CO2 wave is displayed as a curved line.

Fill: The CO2 wave is displayed as a filled area.

**[Wave Scale]**

Change the size of the CO2 waveform by adjusting the wave.

**Measurement limitations**

The following factors may influence the accuracy of measurement:

- The quantitative influence of humidity or condensation.
- The quantitative influence of atmospheric.
- Gas or water steam of interference
- Other sources of interference.

## 14.6 AG Setup

### 14.6.1 AA Setup

Select the parameter area or waveform, the [AA Setup] menu will be displayed:



Setup menu

#### [Apnea Delay]

When the apnea time surpasses the setup time, the patient monitor will show the "CO2 apnea" advanced physiological alarm.

The setting option: 20s, 25s, 30s, 35s, 40s, 45s, 50s, 55s, 60s. The default setting is 20s.

#### [Operating Mode]

Set AG module operating mode, the operation mode can be set to "measure" or "standby".

Measurement mode: AG modules can conduct normal measurement, zero and other operations.

Standby mode: If AG module is not in use, the AG measurement, calibration or other operations are not possible.

#### [O2 Compen]

As to the installed oxygen monitoring module, the module will automatically perform oxygen compensation. And for the non-installed oxygen monitoring module, manually compensation setup is required.

The O2 compensation can be set to high, medium and low. The default is low.

#### [Wave Speed]

AA waveform display for adjusting speed can be set to 6.25mm/s, 12.5mm/s, 25mm/s, the default is 12.5mm/s.

**[Waveform Mode]**

The display of waveform model.

Scanning lines: the line portrayal of AA waveform.

Fill: the display of filling the bottom of AA waveform.

**[Waveform Scale]**

Adjust the position of the ruler on the waveform and the corresponding waveform amplitude will change. It can be set to 3.5, 4.5, 6, 9, 18.

**14.6.2 O2 Setup**

For the AG module which has installed oxygen monitoring, select the O2 parameter area or waveform area, the [O2 Setup] menu will be displayed.

Parameter	Value
Apnea Delay	20s
Wave Mode	Scan
Operating Mode	Measure
Wave Scale	50
Unit	%
Wave Speed	12.5mm/s
Start Zero Cal.	Start Zero Cal.
Alarm Setup	Alarm Setup>>

*O2 Setup menu*

**[Unit]**

It can be set to mmHg, % or kPa, the default is %. N2O and AA unit is %.

**[Waveform Scale]**

Adjust the position of the ruler for waveform of O2 and the O2 waveform amplitude changes accordingly. It can be set to 20, 25, 35, 50, 100. The default is 25.

### 14.6.3 N2O Setup

Select the N2O parameter area or waveform area, the [N2O Setup] menu will be displayed.



*N2O Setup menu*

#### [Waveform Scale]

Adjust the position of the ruler for waveform of N2O and the N2O waveform amplitude changes accordingly. It can be set to 20, 25, 35, 50, 100. The default is 25.

#### 14.6.4 CO2 Setup

Select the CO2 parameter or waveform area, the [CO2 Setup] menu will be displayed.



Fig. 16-6 CO2 Setup menu

##### [Unit]

The unit of CO2 can be set to mmHg, % or kPa, the default is %.

##### [Waveform Scale]

Adjust the position of the ruler for waveform of CO2 and the CO2 waveform amplitude changes accordingly. It can be set to 20, 40, 60, 80. The default is 40.

# Chapter 15. IBP (optional)

## 15.1 Overview

The monitor can monitor up to 4 invasive blood pressures and displays the systolic, diastolic and mean pressures and a waveform for each pressure.

## 15.2 Safety Information

### **Warning**

- **Use only pressure transducers specified in this manual. Never reuse disposable pressure transducers.**
- **When connecting and using accessories, applied parts should avoid from contacting metal parts of electric apparatus.**
- **To reduce the hazard of burns during high-frequency surgical procedure, ensure that the monitor's cables and transducers never come into contact with the high-frequency surgical units.**

## 15.3 Starting Measurement

- Plug the pressure cable into the IBP connector.
- Prepare the flush solution.
- Flush the system to exhaust all air from the tubing. Ensure that the transducer and stopcocks are free of air bubbles.

### **Warning**

- **If air bubbles appear in the tubing system, flush the system with the infusion solution again. Air bubble may lead to wrong pressure reading.**
- **Connect the pressure line to the patient catheter.**
- **Position the transducer so that it is level with the heart, approximately at the level of the midaxillary line.**
- **Select the appropriate label.**
- **Zero the transducer. After a successful zeroing, turn off the stopcock to the atmosphere and turn on the stopcock to the patient.**

### **Warning**

- **If measuring intracranial pressure (ICP) with a sitting patient, level the transducer with the top of the patient's ear. Incorrect leveling may give incorrect values.**

## 15.4 IBP Display

The IBP measurement is displayed on the monitor as a waveform and numeric pressures. For different pressures, display may be different.

Blow image is for reference only, the real display on monitor may be slightly different.

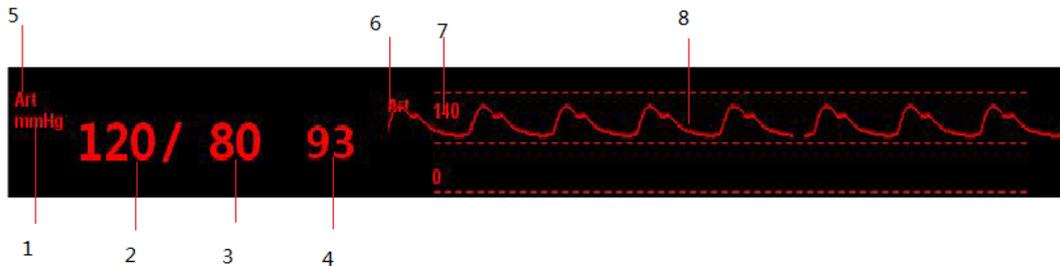


Fig .15.1 IBP Parameter Area and Waveform Area

1. Pressure unit
2. Systolic pressure
3. Diastolic pressure
4. Mean pressure
5. Pressure
6. Waveform name
7. Pressure range
8. Waveform area

For venous pressures, the parameter window shows the mean pressure only. If ICP and one or more of Art, AO, BAP, FAP pressures are measured simultaneously, the ICP parameter area will display numeric cerebral perfusion pressure (CPP), which is obtained by subtracting ICP from the mean pressure of one of the above-mentioned arterial pressures.

When multiple IBP signals are measured, IBP waveforms can be displayed overlappingly in a multi-channel waveform area. All the overlapped waveforms use the same upper, lower gridline, The left side of waveform display arterial pressure name and the gridline(except PA),Right side of waveform display venous pressure name and the gridline.

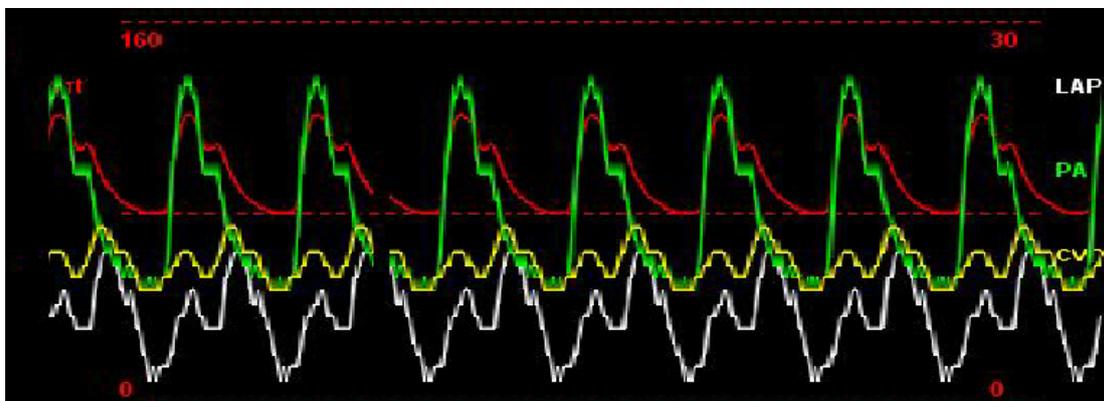


Fig.15.2 IBP Overlap waveform display

## 15.5 IBP Settings

Select any IBP parameter to enter the IBP setup menu:



Fig.15.3 IBP setup menu

### 1. Pressure

Select the pressure you want to change to enter the **【IBP setup】** menu, Select the **【pressure】** and choose what you want from the dropdown list.

Pressure name	Description	Pressure name	Description
Art	Arterial blood pressure	CVP	Central venous pressure
AO	Aortic pressure	LAP	Left atrial pressure
UAP	Umbilical arterial pressure	RAP	Right atrial pressure
BAP	Brachial arterial pressure	ICP	Intracranial pressure
FAP	Femoral arterial pressure	UVP	Umbilical venous pressure
PA	Pulmonary artery pressure	P1~P4	Expansion pressure

### 2. Scale range

When single IBP waveform displays, Scale range can setup to: Auto、-10~10、0~20、0~30、-10~40、0~40、-50~50、0~60、0~80、-10~120、0~140、30~140、60~140、0~160、0~200、0~240、-50~300、50~300(Unit mmHg), User can choose scale range according to measuring site. Scale default setting is auto, monitor will adjust the IBP scale automatically according to the IBP measurement result.

When multiple IBP waveforms overlay display, the scale range consists of 2 parts: left scale range and right scale range. Left scale range is arterial pressure range (except PA), adjustable range of -50~300mmHg.and the right side scale range is venous pressure, can be adjusted in the range of -10~120mmHg.

### 3. Filter Mode

Can be set to 40HZ、12HZ,Default is 40HZ.

### 4. Wave Speed

Wave Speed can be set to 12.5mm/s、 25mm/s, Default is 25mm/s。

5. Pressure unit

Select any IBP parameter area, enter the **【IBP Setup】** you can change the pressure unit of all the IBP parameter area and waveform area. Pressure unit can be set to mmHg, KPa, default display is mmHg.

6. Zero Calibration

Zero Calibration should be done after connecting the sensor.

7. Pressure type setup

Set the pressure type of extension pressure P1~P4, Pressure type can be set to arterial pressure or venous pressure.

8. IBP waveform display mode

IBP waveform display mode: single or overlap, default is single display. IBP wave overlap display need to enter the **【screen setup】** choosing IBP overlap.

# Chapter 16. C.O. (optional)

## 16.1 Overview

Cardiac output (C.O.) module is inserted into the plug-in slot of the monitor for C.O. measurement. C.O. measurement adopts the thermodilution method to invasively measure the cardiac output and other hemodynamic parameters in order to determine the flow rate of the blood circulation system.

As for the thermal dilution method, the cold solution is introduced into the blood circulation system, and measuring the resulting drop in temperature at a downstream site. In the window of the C.O. measurement, the temperature change is shown as a curve, and the monitor will calculate the C.O. value according to this curve. The C.O. value is inversely proportional to the area under this curve. Cardiac output is a continuous variable; therefore, to obtain a reliable C.O. average value, a series of measurements must be carried out. Generally, the average value of multiple thermal dilution measurements is used for therapy decision.

### 16.1.1 Safety Information

**⚠ Warning:**

- Never reuse the disposable accessories.
- Never touch the C.O. connecting cable when defibrillation is carried out during the C.O. monitoring period. Otherwise, electric injury, electric shock or other damages might be caused
- Do not soak or wet the connector.
- Do not soak the C.O. connecting cable in alcohol; otherwise, the connecting cable might be hardened or damaged.
- Never sterilize the C.O. connecting cable at high pressure.

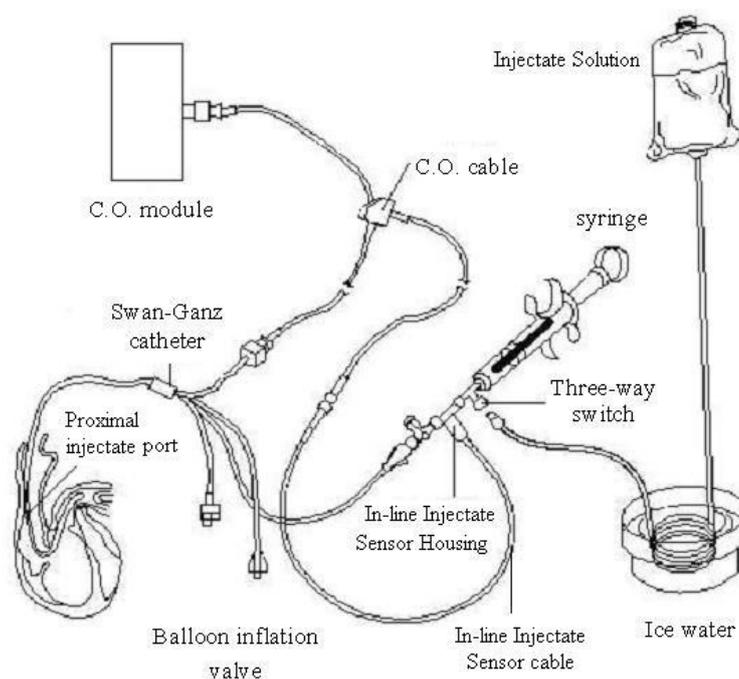
### 16.1.2 C.O. Display

There is no waveform display of C.O. measurement on the main interface, only the value of C.O., TB (temperature of blood), TI (injectate temperature), C.I.(cardiac index) and the prompt info can displayed in the parameter zone. See the interface in the following figure:



## 16.1.3 Measurement of C.O.

- Insert the C.O. interface cable to the C.O. module.
- As shown in the following figure, insert the thermistor connecting cable of the Swan-Ganz catheter into the thermistor connector, and connect the In-line Injectate sensor cable to the In-line Injectate Sensor Housing.



- Select the C.O. parameter zone to enter into the menu of **【C.O. Setup】**, and select the **【C.O. Measure】** to enter into the measurement window.
- If the **【Measure Mode】** in the **【Setup C.O.】** is set as single, when the words “Ready for New measurement” are displayed on the screen, select the **【Start】** to start the C.O. measurement. When there is prompt information “Inject now...” on the screen, please inject the solution to the right atrium port of the Swan-Ganz catheter. The optimal injection rate is 2.5ml/s. The cardiac output, cardiac index and corresponding curve will display in the measurement window in real time

## 16.1.4 C.O. Setting

Select the C.O. parameter zone to open the menu of **【C.O. Setup】**, and set the items in the menu

## 16.1.5 C.O. Measurement

Select the **【C.O. Measure】** to open the C.O. measurement window as shown in the following figure, please pay attention that whether the TB cable is well connected and the value of C.O. setting is correspond with actual value before C.O. measurement.



Below the C.O. measurement window, the following function buttons are included:

**【Start】** : Start a C.O. measurement.

**【Delete】** : Selectively delete the measured values in the historical measurement window.

**【Hemodynamic】** : Open the menu of **【Hemodynamic】** . See 1.5.4 of this chapter for the detailed content of the menu.

**【C.O. ITEM】** : Open the C.O. item to browse the measurement results.

**【Setup Scale】** : Open the menu of scale setting to adjust the scale range.

**【Setup C.O.】** : Open the menu of **【Setup C.O.】** . See 1.5.2 of this chapter for the detailed content of the menu.

**【Record】** : Record the latest measurement curve and measurement result.

## 16.1.6 C.O. Setting

Select the **【Setup C.O.】** to set the items in the C.O. setting window in proper order.

- **【Measure Mode】** : Single mode or continuous mode is optional.
- **【TI Source】** : The temperature source of injectate can be input by the user or measured by the injectate temperature probe. The options include manual and auto. When **【Auto】** is set, the temperature of injectate can be obtained through the In-line Injectate sensor cable in real time.
- **【Setup TI】** : When the **【TI Source】** is automatic, the TI is unadjustable;
- when the **【TI Source】** is manual, the TI is adjustable.

- **【Inj.Vol】** : 3cc, 5cc or 10cc is optional.
- **【Cath.Const】** : The set value of the constant can be obtained in the document attached to the Swan-Ganz catheter, which depends on the injectate volume, temperature and the catheter type. To change this value, please select the catheter constant in the window of **【Setup C.O.】** , and input the correct value.
- **【Weight】** : Set the correct patient's body weight, which is used to calculate the hemodynamic and other parameters.
- **【Height】** : Set the correct patient's height, which is used to calculate the hemodynamic and other parameters.
- **【TEMP Unit】** : °C or °F is optional.

### 16.1.7 Alarm-related Settings

- Select the **【Alm Switch】** in the menu of **【C.O. Setup】** to open or close the alarm.
- Select the **【Alm Level】** in the menu of **【C.O. Setup】** ; the alarm is divided into low, med and high according to the severity of the alarm.
- Select the **【TB Hi Lmt】** in the menu of **【C.O. Setup】** to set the alarm upper limit of the blood temperature.
- Select the **【TB Lo Lmt】** in the menu of **【C.O. Setup】** to set the alarm lower limit of the blood temperature.

### 16.1.8 Hemodynamic

Select the **【C.O. Measure】** in the menu of **【C.O. Setup】** , and select the **【Hemodynamic】** in the menu bar below the C.O. measurement window to open the hemodynamic window.

Important hemodynamic parameter values are displayed in the hemodynamic window. These parameters consist of parameters for monitoring and parameters for calculation. Select the **【Calculation】** to switch the display of parameters for monitoring and parameters for calculation.

Parameters for monitoring refer to the input values which can be obtained from the patient monitoring data and the values which are inputted manually. The parameters for monitoring, the identifications and the corresponding measurement units are as shown in the following figure:

Parameter	Abbreviation	Unit
Cardiac output	C.O.	L/min
Heart rate	HR	bpm
Pulmonary artery wedge pressure	PAWP	mmHg
Mean artery pressure	MAP	mmHg
Mean pulmonary artery pressure	MPAP	mmHg
Central venous pressure	CVP	mmHg
End diastolic volume	EDV	mL
Height	Height	cm
Weight	Weight	kg

Parameters for calculation refer to the parameter values automatically calculated by the selection of **【 Calculation 】**. The parameters for calculation, the identifications and the corresponding measurement units are as shown in the following figure:

Paramete	Full Name	Unit
C.I.	Cardiac index	L/min/m <sup>2</sup>
BSA	Body surface area	m <sup>2</sup>
SV	Stroke volume	mL
SVI	Stroke index	mL/m <sup>2</sup>
SVR	Systemic vascular resistance	dyn·s/cm <sup>5</sup>
SVRI	Systemic vascular resistance index	dyn·s·m <sup>2</sup> /cm
PVR	Pulmonary vascular resistance	dyn·s/cm <sup>5</sup>
PVRI	Pulmonary vascular resistance index	dyn·s·m <sup>2</sup> /cm
LCW	Left ventricular work	kg·m
LCWI	Left ventricular work index	kg·m/m <sup>2</sup>
RCW	Right ventricular work	kg·m
RCWI	Right ventricular work index	kg·m/m <sup>2</sup>
LVSW	Left ventricular stroke work	g·m
LVSWI	Left ventricular stroke work index	g·m/m <sup>2</sup>
RVSW	Right ventricular stroke work	g·m
RVSWI	Right ventricular stroke work index	g·m/m <sup>2</sup>
EF	Ejection fraction	%

The functions of the buttons below the display window of parameters for calculation are as follows:

**【<<\*/\*】** and **【>>\*/\*】** : Display the historical input values and the calculation results.

**【Range】** : Display the normal range or the unit.

【Record】 : Print the calculation results.

【Show Input】 : Switch the display of the input values and the calculation results.

## 16.1.9 Measurement Restrictions

C.O. measurement has its restrictions. It is inadvisable to carry out C.O. measurement when the patient is under one or more of the following circumstances:

Patient with poor immune system

- ◆ Patient with right heart valve disease
- ◆ Patient with blood coagulation disorder
- ◆ Patient with vessel disease
- ◆ Patient with thrombolytic therapy
- ◆ Patient with pulmonary hyperpiesia
- ◆ Patient with pacemaker
- ◆ Patient with systemic hypotension

## 16.1.10 Influencing Factors

Some factors influencing the cardiac output include:

- The temperature and volume of Injectate solution
- The injection rate, the frequency and the interval
- The position of catheter relative to the lung
- The injection technique of the operator

# Chapter 17. BIS (optional)

## 17.1 Introduction

Bispectral Index (BIS) monitoring helps to monitor the level of consciousness of a patient under general anesthesia or sedation in the OR and ICU. The BIS sensor is placed on the patient's forehead to capture electroencephalographic (EEG) signals from which several numerics are derived, including a single BIS between 100 (wide awake) and zero (absence of brain electrical activity) that represents the patient's level of consciousness. This enables clinicians to customize

the precise type and amount of anesthetic or sedative medication that each patient needs.

BIS module is produced by Aspect Medical Company. This module uses the electrical activity in the cerebral cortex EEG, combines bispectral index and spectral analysis method, given certain amount of bispectral index, combined with the quality of EEG analysis of comprehensive evaluation of factors such as the patient's current state of consciousness, to identify the anesthetic depth.

## 17.2 Safety Information

For patients with neurological disorders, patients taking psychoactive medication, and children below the age of 1 year, BIS values should be interpreted cautiously.

### ⚠ WARNING

- **The conductive parts of sensors and connectors should not come into contact with other conductive parts, including earth.**
- **To reduce the hazard of burns in the high-frequency surgical neutral electrode connection, the BIS sensor should not be located between the surgical site and the electro-surgical unit return electrode.**
- **The BIS sensor must not be located between defibrillator pads when a defibrillator is used on a patient connected to the patient monitor. The BIS sensor must not be located between defibrillator pads when a defibrillator is used on a patient connected to the patient monitor.**
- **To avoid the risk of strangulation, BIS module sensor cable must be carefully placed and fixed.**

## 17.3 BIS Display

The BIS module provides BIS, SQI, EMG, SR, SEF, TP, PC value and 2 channel EEG wave, as following:



Fig. 18-1 BIS parameter area

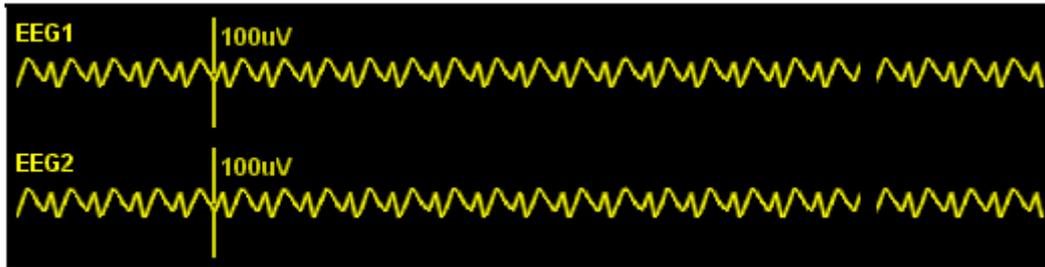


Fig. 18-2 EEG waveform

### 1. Bispectral Index (BIS)

The BIS numeric reflects the patient's level of consciousness. It ranges from 100 for wide awake to 0 in the absence of brain activity.

BIS numeric	BIS value description
100	The patient is widely awake.
70	The patient is underdosed but still unlikely to become aware.
60	The patient is under general anesthesia and loses consciousness.
40	The patient is overdosed and in deep hypnosis.
0	The EEG waveform is displayed as a flat line, and the patient has no electrical brain activity.

### 2. Electromyograph (EMG)

EMG bar graph reflects the electrical power of muscle activity and high frequency artifacts. The minimum possible EMG is about 25 dB.

- ◆ EMG < 55 dB: this is an acceptable ECG.
- ◆ EMG ≤ 30 dB: this is an optimal EMG.

### 3. Suppression Ratio (SR)

SR numeric is the percentage of time over the last 63-second period during which the EEG is considered to be in a suppressed state.

### 4. Spectral Edge Frequency (SEF)

The SEF is a frequency below which 95% of the total power is measured

### 5. Signal Quality Index (SQI)

The SQI numeric reflects signal quality and provides information about the reliability of the BIS, SEF, TP, and SR numerics during the last minute.

It ranges from 0-100%:

- ◆ SQI < 15%: the numerics cannot be derived.
- ◆ SQI 15 to 50%: the numerics cannot be reliably derived.
- ◆ SQI 50% to 100%: the numerics are reliable.

### 6. Total Power (TP)

TP numeric indicates the power in the frequency band 0.5-30Hz. The useful range is 30-100db.

## 17.4 Set up the BIS Measurement

1. Connect the BISx model to the BIS interface of the patient monitor.



Fig. 18-3 BISx module connection

2. Use the attachment clip to secure the BISx model near, but not above the level of the patient's head.
3. Attach the BIS sensor to the patient following the instructions supplied with sensor.

### ⚠NOTE

**Make sure the patient's skin is dry. A wet sensor or a salt bridge could result in erroneous BIS and impedance values.**

4. Connect the BIS sensor to the patient interface cable. As soon as a valid sensor is detected, the impedances of all electrodes are measured automatically and the impedance value for each electrode is displayed in the sensor check window.

### ⚠CAUTION

**Do not attach the BISx model to the patient's skin for long time. Otherwise, the BISx heats while on the patient and may cause discomfort.**

## 17.5 BIS Setup menu

【BIS Setup】 menu is shown as below:

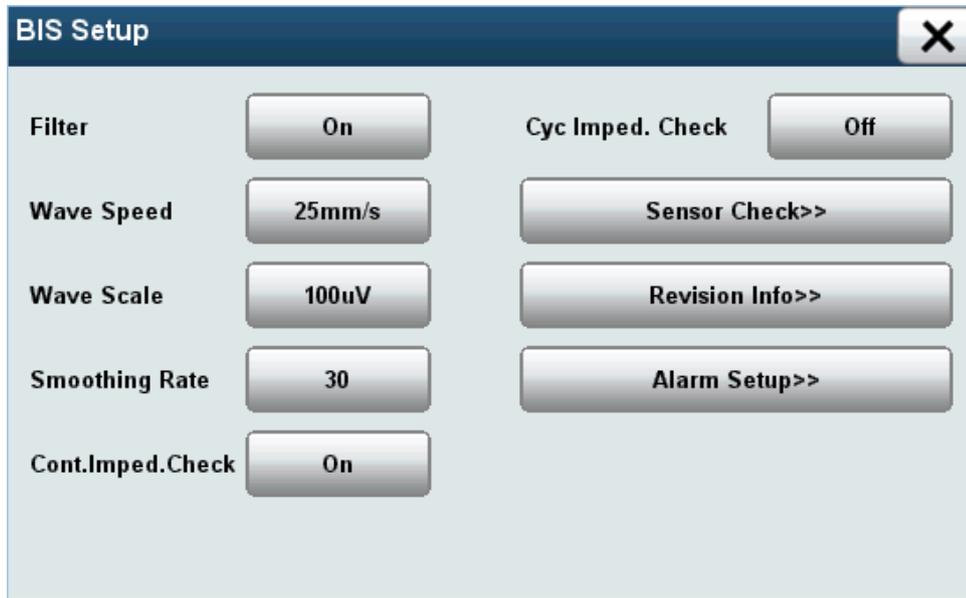


Fig.18-4 BIS Setup menu

### 17.5.1 Continuous Impedance Check

By default, this check is switched on. It checks:

- ◆ The combined impedance of the signal electrodes plus the reference electrode. This is done continuously and does not affect the EEG wave. As long as the impedances are within the valid range, there is no prompt message of this check or its results.
- ◆ The impedance of the ground electrode. This is done every ten minutes and takes approximately four seconds. It causes an artifact in the EEG wave, and the message [BIS Ground Checking] is displayed on the monitor during the check. If the ground electrode does not pass this check, another check is initiated. This continues until the ground electrode passes the check.

If the continuous impedance check interferes with other measurements, it can be switched off.

To do this:

- ◆ Enter 【BIS setting】, Select [Cont. Imped. Check] and then select [On] or [Off].

#### ⚠ CAUTION

- Switching the continuous impedance check off will disable automatic prompt to the user of impedance value changes, which may lead to incorrect BIS values. Therefore, this should only be done if the check interferes with or disturbs other measurements.
- When use semi-reusable sensor, continuous impedance monitoring cannot be turned off. If turn off the checking when sensor is connected, it will automatically open.

## 17.5.2 Cyclic Impedance Check

This measures the exact impedance of each individual electrode. It causes a disturbed EEG wave, and **【BIS Impedance Check】** is displayed on the monitor

■ The cyclic impedance check is automatically initiated when a sensor is connected. To manually start a cyclic impedance check manually, you can:

- ◆ Select **【Cyc Imped. Check】** in the **【BIS Setup】** menu and then select **【On】** or **【Off】**.

The cyclic impedance check stops automatically if the impedances of all electrodes are within the valid range. To manually stop a cyclic impedance check, you can:

- ◆ Select **【Cyc Imped. Check】** in the **【BIS Setup】** menu and then select **【On】** or **【Off】**.

If **【Cyc Imped. Check】** has stopped before ground electrode impedance check pass, it will automatically start the ground electrode impedance check, and cannot be disconnected.

## 17.5.3 BIS Sensor Check

To start sensor check, select **【Sensor Check >>】** in the **【BIS Setup】** menu.

The graphic in the BIS sensor check window automatically adapts to show the type of sensor you are using, show three or four electrodes as required. Each symbol in the graphic represents an electrode and illustrates the most recently-measured impedance status of the electrodes: 1 is the reference electrode; 2 the ground electrode; 3 and 4 are signal electrodes.

In addition, if it detects any electrode or combination electrode to skin impedance higher than the limit or the electrode fall off, it will generate alarm **【BIS impedance high】** or **【Lead off】**

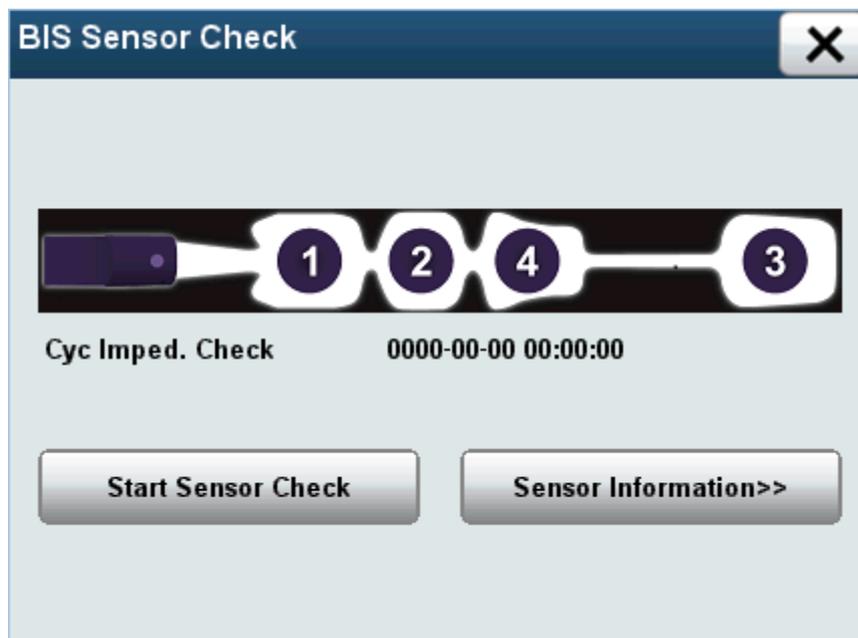


Fig. 18-5 BIS sensor check

Status	Action
Pass	No action necessary.
BIS impedance high	Check the sensor-to-skin contact. If necessary, clean and dry skin.
Failed	<ol style="list-style-type: none"> <li>1. 1.Reconnect electrode, or check the sensor-to-skin contact. If necessary, clean and dry skin.</li> <li>2. Check the sensor-to-skin contact. If necessary, clean and dry skin.</li> </ol>

## 17.5.4 Filter

Low pass and high pass filters can filter out undesirable interference from the raw EEG waveform display. Notch filter can filter frequency lines interference. Filter settings will affect the EEG waveform and SEF and TP values, but does not affect the BIS, EMG, SR, SQI value.

To set up filter, Select **【Filter】** to **【On】** or **【Off】** in the **【BIS Setup】** menu,

## 17.5.5 BIS Smoothing Rate

The smoothing rate defines how the monitor averages the BIS value.

Enter the **【BIS Setup】** menu, select **【Smoothing Rate】** to change smoothing rate you need.

- ◆ 15 seconds: With this smoothing rate, the monitor provides increase responsiveness to changes in the patient's state.
- ◆ 30 seconds: The monitor provides a smoother BIS trend with decreased variability and sensitivity to artifact.

## 17.5.6 Wave scale

Change the scale only change the appearance of the waveform, it does not affect the signal analysis, nor does it impact report record or the print signal.

Enter the **【BIS setup】** menu, select **【wave scale】** to adjusted the scale. The optional scale value : 50uV, 100uV, 200uV 500uV. EEG waveform vertical line appear on the scale, and its height is equal to the amount of uV value.

## 17.5.7 Revision info

Showing display sensor, BIS module version info.

# Chapter 18. NMT (optional)

## 18.1 Overview

Monitoring the effect of neuromuscular blocking agents (NMBAs) can be accomplished in several ways.

The most frequently used method is clinical evaluation using a peripheral nerve stimulator.

Although the technique is simple, it lacks accuracy because of its subjective interpretation of the responses.

Accurate and objective information on the degree of neuromuscular paralysis can be obtained by measuring the force of contraction of a certain muscle (mechanomyography).

However, the equipment needed is rather bulky and difficult to use during routine surgery because of the elaborate set-up procedure and its sensitivity to movement.

A good alternative for force measurement of acceleration (acceleromyography). According to the second law of Newton: Force equals Mass times Acceleration ( $F=Ma$ ), the acceleration of a muscle has a linear correlation with the contraction force of that muscle. It has been shown that there is a good correlation between the results of acceleromyography and mechanomyography.

## 18.2 Short Set-up

### 18.2.1 Checking Patients For Muscle Relaxation

In the set-up menu of the TOF-Watch, display of the stimulation strength can be switched from mA (default setting) to  $\mu$ C, according to local preferences. As a default setting, the stimulation current is set at 50 mA.

- 1、 Place electrodes in position, attach the acceleration transducer to the thumb with adhesive tape.
- 2、 Turn TOF-Watch on by pressing the  button (1) and holding it down for 1s.
- 3、 Administer the induction agent.
- 4、 When the patient is adequately sedated, press  (2) for automatic calibration (optional).
- 5、 Hold down the  button (3) for repetitive TOF stimulation.

The TOF-Watch is now ready for the further monitoring of neuromuscular transmission.

During surgery muscle relaxation can be monitored continuously to assess the need for either repeated administration of a muscle relaxant or for the use of a reversal agent during recovery.

## 18.2.2 Checking Patient For Residual Curarization

The use of the automatic set-up of the TOF-Watch on patients already relaxed will result in incorrect selection of internal gain due to fading. The following procedure should be used:

- 1、 Place electrodes in position ,attach the acceleration transducer to the thumb with adhesive tape .
- 2、 Turn TOF-Watch on by pressing the  button(1)and holding it down for 1s.
- 3、 The strength of the stimulation (mA or  $\mu\text{C}$ ) can be adjusted manually by pressing the mA( $\mu\text{C}$ ) up (21) or down button (23).

- 4、 Press  (3).

Since no control twitch height has been established ,only the TOF ratio yields information about the recovery of a patient and not a single twitch measurement .

## 18.2.3 Nerve Location For Loco-regional Anesthesia

The TOF-Watch can be used as an aid in nerve location for loco-regional anesthesia using a special stimulation cable .This cable contains one lead with a connector fitting to a surface electrode and one lead with a connected to a needle electrode.

Once this cable is inserted in the TOF-Watch, the instrument automatically reverts to the locoregional anesthesia mode . Since only a ,visual assessment of the response is needed,no responses are shown on the display.

- 1、 Connect special stimulation cable to the TOF-Watch
- 2、 Place the surface electrode in position
- 3、 Turn TOF-Watch on by pressing the  button(1)and holding it down for 1s.
- 4、 Start the repetitive 1Hz stimulation by pressing the  (24)button
- 5、 The strength of the stimulation (mA or  $\mu\text{C}$  , shown on the display) can be adjusted manually by pressing the mA (  $\mu\text{C}$ ) up button (21) or down button (23).

The TOF-Watch is now ready for use in locating the nerve with the needle electrode .

## 18.3 Pre-Operative Set-up

### 18.3.1 Cable Connections (Objective Monitoring)

The TOF-Watch can be used for objective monitoring by using two cables:

A) Acceleration transducer cable and B) stimulation cable.

When surface electrodes are used, the instrument automatically uses stimulation pulses of 200 $\mu\text{s}$  (300 $\mu\text{s}$ ) at 0-60 mA(0-12/18 $\mu\text{C}$ ).The pre-defined default current is set at 50 mA.

Attach the simulation cable to the surface electrodes placed on the ulnar nerve .

Attach the acceleration transducer with its largest flat side to the thumb by means of adhesive tape . Connect both cables to designated color-coded outlets on the TOF-Watch(reversal of the cables is not possible because of a mechanical barrier).

### **18.3.2 Cable Connections (Subjective Monitoring)**

When the acceleration transducer is not connected to the TOF-Watch, the instrument can be used as a peripheral nerve stimulator.

When surface electrodes are used ,the TOF-Watch automatically shows only the stimulation strength in mA( $\mu$ C) and stimulation mode .

The pre-defined default stimulation strength is set at 50 mA. Attach the simulation cable to the surface electrodes placed on the ulnar nerve (see above ) ,and connect to the designated color-coded outlet on the TOF-Watch(insertion of the cable in the wrong outlet is not possible because of a mechanical barrier).

### **18.3.3 Cable Connections (Loco-regional Anesthesia)**

When the special cable for a needle electrode is used, the TOF-Watch can be used for nerve location in loco-regional anesthesia.

The TOF-Watch will automatically revert to the loco-regional anesthesia mode ,enabling stimulation with a pulse width of 40 $\mu$ s, and a current ranging between 0 and 6.0mA.

The total charge delivered varies between 0 and 0.24 $\mu$ C.In the set-up menu ,display of the strength of the simulation can be switched from $\mu$ C(pre-installed) to mA.

The pre-defined default setting is 0 $\mu$ C .Patient responses are not shown on the display .

Attach the special cable to a needle electrode and a surface electrode , and connect to the designated color-coded outlet on the TOF-Watch(insertion of the cable in the wrong outlet is not possible because of a mechanical barrier).

### **18.3.4 Electrodes**

When monitoring neuromuscular transmission ,the TOF-Watch should always be used with round surface electrodes with snap connection .Small(pediatric) electrode are advisable to obtain a sufficient current density. In order to ensure a steady quality of the test, be sure only to use CE marked electrodes.

### **18.3.5 Electrode Placement**

Acceleromyography can take place by stimulating the facial nerve and monitoring the response of the orbicularis oculi muscle or by stimulating the posterior tibial nerve and monitoring the response of the flexor hallucis brevis muscle. However, stimulation of the ulnar nerve and acceleration measurements at the adductor pollicis is preferred for routine monitoring.

The electrodes are placed over the ulnar nerve on the volar side of the wrist. The distal electrode is

positioned where the proximal bending line crosses the radial side of the flexor carpi ulnaris muscle. The proximal electrode can be placed either 2 to 3 cm proximal of the distal electrode or over the ulnar nerve at the elbow.

- Correct positioning of the electrodes is important. Small displacement may result in considerable changes in stimulation current requirements. Furthermore, the electrodes must be positioned in such a way to avoid direct stimulation of the muscle.
- Place the electrodes on each side of the expected position of the ulnar nerve. In this way, the effect of any minor misjudgment of the actual nerve position is minimized.
- It has been found that slight pressure on the electrodes may improve the stimulation considerably. Therefore, taping the electrodes to the skin may be advisable.

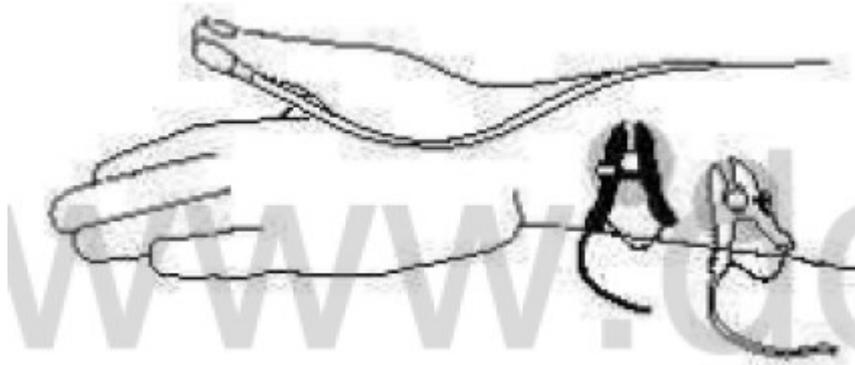


Figure 2. Electrode and transducer placement

### 18.3.6 Position Of The Transducer

The transducer should be placed with its largest flat side against the thumb.

The transducer cable must be fixed in such a way that no traction is applied to the transducer and that movement of the thumb is not obstructed in any way.

- Small sideways movements of the thumb may be noticed during stimulation. If this is the case, reposition the transducer in such a way that the movement is perpendicular.
- The more distal the transducer is placed on the thumb, the stronger the acceleration signal. This effect can be used to adjust the signal strength.

### 18.3.7 Arm Position

The arm, used for the acceleration measurement, should be kept immobile during the whole procedure. Movement of the arm to another position may change the twitch height considerably. Although the twitch height may still differ from the original value, the train-of-four ratio will not be affected. At later stages of recovery the patient may perform voluntary movements of the hand, which in turn may disturb the measurements and recordings.

### 18.3.8 Connection To Stimulator

Always make sure that the TOF-Watch is switched off or that the display shows the stop symbol



(7) before touching the electrodes.

The proximal electrode is usually connected to the white (positive) clip on the stimulator cable.

The distal electrode should be connected to the black (negative) clip.

If both electrodes are near the wrist, the polarity is less critical. The stimulator pulses are

monophasic. Switching the electrode connection (exchanging  with ) may sometimes increase the stimulation considerably.

### 18.3.9 Skin Resistance

The skin resistance together with the electrode resistance forms the total resistance in the stimulating circuit. The stimulator in the TOF-Watch is of the constant current type.

This means that the stimulation voltage automatically increases with the resistance.

As long as the voltage remains below the maximum value (=300V) the stimulator can deliver the selected pulse. For a maximal current of 60mA, the maximal resistance will be 5KOhm.

If the resistance is above this value, the “skin resistance too high” symbol  (12) will be displayed, and the stimulation stops. If the current is reduced, the corresponding voltage drops and stimulation can be resumed.

- Insufficient cleaning of the skin may be the cause of a too high skin resistance.  
Note that there is not necessarily any relation between high skin resistance and problems of reaching supramaximal stimulation

### 18.3.10 Control Twitch Height

The patient should be anesthetized before operating the stimulator because nerve stimulation can be painful for a conscious patient.

Control twitch height is the twitch height when the patient is not relaxed. Control twitch height is set to 100% at calibration.

### 18.3.11 Calibration

The size of the transducer signal varies from patient to patient. In order to establish a control twitch

height value of 100% for the 1Hz or 0.1 Hz modes, the transducer gain is set by pressing the  button (22) for more than 1s.

- If the responses of a non-relaxed patient are too small for an accurate measurement, as can be seen in children or when using the orbicularis oculi muscle, then a gain calibration will optimize the sensitivity.

### 18.3.12 Sensitivity

It may be observed that the thumb makes very small movements although no response is shown on the display . This is not an error: the movement is below the threshold of 3% control twitch height at which the TOF-Watch starts to display the responses.

### 18.3.13 Stimulation Units

The TOF-Watch can show the strength of the electrical stimulation in both milli-amperes [Ma] and micro-coulomb [µC] . For routine monitoring the default setting is in mA, for use in locoregional anesthesia the default setting is in µC . It is possible to change between the two modes in the set-up menu.

### 18.4 NMT Display

The monitor displays NMT parameter on the normal screen. Fig. 7-4 below is the monitoring interface of NMT, and is for reference purposes only. The graphics displayed on your monitor may be slightly different.

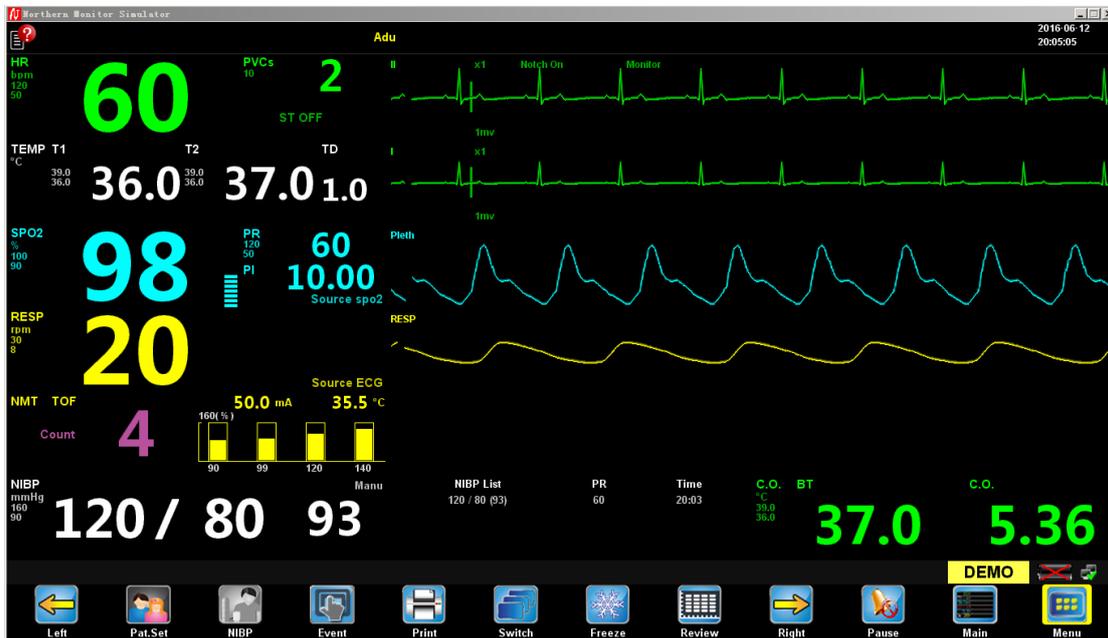


Fig. 20-1NMT Parameter in Normal Screen

# Chapter 19. Calculate

## 19.1 Overview

This monitor provides computing capabilities, the calculated values are not directly measured patient data, but the results from the monitor calculated according to the appropriate data you provide.

The following calculations can be performed on the monitor:

- Hemodynamic  Calculation
- Dose Calculation
- ventilation calculation
- renal function calculation
- oxygenation calculation
- MEWS system

To calculate something, in the main menu, select [calculate], select a different calculation function to calculate.



### Notes

- Calculation is independent of the other features of the monitor, the patient can not object computing monitor the guardianship. Calculating operation will not affect the care of patients who are



### Warning

- Should be carefully calculated to verify the correctness of input parameters and results of suitability. The Company does not assume any responsibility for all the consequences of input and operational errors caused by

## 19.2 Dose Calculation

### 19.2.1 Calculating Step

- 1, in the menu, select [calculate] → [Dose Cal.].
2. Select the type [patient cat.] and [Drug Name]. In [Drug Name] drop-down list on the right, you can select the required drug name from the following 15 kinds of medicines. Among them, the name of the drug A, B, C, D, E can be defined by the user.

Drug A, B, C, D, E

Aminophylline

Dobutamine

Dopamine

Epinephrine  
Heparin  
Isuprel  
Lidocaine  
Nipride  
Nitroglycerin  
Pitocin

3, after the completion of the previous operation, the system will automatically give a default value. These data can not be calculated as a result, they must enter the known, the correct parameter values according to the doctor's instructions.

4. Enter the weight of the patient.

5, enter the correct parameter values

6, confirm the correctness of the calculation results

## 19.2.2 Unit Of Measurement

Each drug fixed unit or unit series are calculated. In the same unit in the series, will hexadecimal parameter values with the input of the unit is automatically adjusted.

Units of various drugs as follows:

Drug A, B, C, aminophylline, dobutamine, dopamine, epinephrine, isoproterenol, lidocaine, nitroglycerin and sodium nitroprusside, using a series of units: g, mg, mcg.

Drug D, Heparin and oxytocin, the use of series unit: unit, KU, MU.

Drug E use Unit: mEq

When a custom of certain drugs, the operator should be the drug of choice in accordance with Series A, B, C, D, E.

## 19.2.3 Titration Table

After completion of the drug calculation, Drug calculation titration table] window, select ["] to open the titration table.

In the titration table, you can change:

- [Reference]
- [Interval]
- [ Dose type]

After you change the above options, the titration data in the table will change accordingly.

you can also:

Select  and  button to select and observe more data.

## 19.3 Oxygenation Calculation

### 19.3.1 Calculating Step

- 1, in the menu, select [calculate] → [Oxygenation Cal.].
  - 2, enter the correct values for each parameter.
  3. Select the [calculate] button, you can calculate the value of each output parameter.
- For beyond the reasonable range of output value, which is shown as a yellow background. Now all parameters will disappear behind the unit, parameter out of range, reasonable range will be displayed.
  - [---] indicates an invalid value

### 19.3.2 Input Parameter

Abbreviation	Unit	English full name
C.O.	L/min	Cardiac output
FiO <sub>2</sub>	%	Percentage fraction of inspired oxygen
PaO <sub>2</sub>	mmHg	Partial pressure of oxygen in the arteries
PaCO <sub>2</sub>	mmHg	Partial pressure of carbon dioxide in the arteries
SaO <sub>2</sub>	%	Arterial oxygen saturation
PvO <sub>2</sub>	mmHg	Partial pressure of oxygen in venous blood
SvO <sub>2</sub>	%	Venous oxygen saturation
Hb	g/L	Hemoglobin
CaO <sub>2</sub>	ml/L	Arterial oxygen content
CvO <sub>2</sub>	ml/L	Venous oxygen content
VO <sub>2</sub>	ml/min	Oxygen consumption
RQ		Respiratory quotient
ATMP	mmHg	Atmospheric pressure
Height	cm	Height
weight	Kg	weight

### 19.3.3 Output Parameter

Abbreviation	Unit	English full name
BSA	m <sup>2</sup>	Body surface area
VO <sub>2</sub> calc	ml/min	Oxygen consumption
C(a-v)O <sub>2</sub>	ml/L	Arteriovenous oxygen content difference
O <sub>2</sub> ER	%	Oxygen extraction ratio
DO <sub>2</sub>	ml/min	Oxygen transport
PAO <sub>2</sub>	mmHg	Partial pressure of oxygen in the alveoli

AaDO <sub>2</sub>	mmHg	Alveolar-arterial oxygen difference
CcO <sub>2</sub>	ml/L	Capillary oxygen content
Qs/Qt	%	Venous admixture
C.O. calc	L/min	Calculated cardiac output

## 19.4 Ventilation Calculation

### 19.4.1 Calculating Step

- 1, in the menu, select [computing "] → [Ventilation Calculation].
  - 2, enter the correct values for each parameter.
  3. Select the [computing] button, you can calculate the value of each output parameter.
- For beyond the reasonable range of output value, which is shown as a yellow background. Now all parameters will disappear behind the unit, parameter out of range, reasonable range will be displayed.
  - [---] indicates an invalid value

### 19.4.2 Input Parameter

Abbreviation	Unit	English full name
FiO <sub>2</sub>	%	Percentage fraction of inspired oxygen
RR	Rpm	Respiration rate
PeCO <sub>2</sub>	mmHg	Partial pressure of mixed expiratory CO <sub>2</sub>
PaCO <sub>2</sub>	mmHg	Partial pressure of carbon dioxide in the arteries
PaO <sub>2</sub>	mmHg	Partial pressure of oxygen in the arteries
TV	ml	Tidal volume
RQ		Respiratory quotient
ATMP	mmHg	Atmospheric pressure

### 19.4.3 Output Parameter

Abbreviation	Unit	English full name
PAO <sub>2</sub>	mmHg	Partial pressure of oxygen in the alveoli
AaDO <sub>2</sub>	mmHg	Alveolar-arterial oxygen difference
Pa/FiO <sub>2</sub>	mmHg	Oxygenation ratio
a/AO <sub>2</sub>	%	Arterial to alveolar oxygen ratio
MV	L/min	Minute volume
V <sub>d</sub>	ml	Volume of physiological dead space
V <sub>d</sub> /V <sub>t</sub>	%	physiological dead space in percent of tidal volume
VA	L/min	Alveolar volume

## 19.5 Hemodynamic Calculation

### 19.5.1 Calculating Step

- 1, In the menu, select [calculate] → [Hemodynamic Cal.].
  - 2, enter the correct values for each parameter.
- If the patient is under guardianship is calculated, then HR, Art Mean, PA Mean CVP and the default value is the current real-time measurements; If you have just performed CO measurements, the default value CO is chosen more times the average CO measurements; height and weight from the patient information entered. When the monitor can not be selected to provide these data, the display is blank, you need to manually enter.
  - If the patient is not on the guardianship of the calculation, you need to verify or modify all input values.
3. Select the [calculate] button, you can calculate the value of each output parameter.
- For beyond the reasonable range of output value, which is shown as a yellow background. Now all parameters will disappear behind the unit, parameter out of range, reasonable range will be displayed.
  - [---] indicates an invalid value

### 19.5.2 Input Parameter

Abbreviation	Unit	English full name
C.O.	L/min	Cardiac output
HR	bpm	Heart rate
PAWP	mmHg	Pulmonary artery wedge pressure
Art Mean	mmHg	artery mean pressure
PA Mean	mmHg	Pulmonary artery mean pressure
CVP	mmHg	Central venous pressure
EDA	ml	End-diastolic volume
Height	cm	Height
weight	Kg	weight

### 19.5.3 Output Parameter

Abbreviation	Unit	English full name
C.I.	L/min/m <sup>2</sup>	Cardiac index
BSA	m <sup>2</sup>	Body surface area
SV	ml	Stroke volume
SI	ml/m <sup>2</sup>	Stroke index
SVR	DS/cm <sup>5</sup>	Systemic vascular resistance
SVRI	DS/ m <sup>2</sup> /cm <sup>5</sup>	Systemic vascular resistance index

PVR	DS/cm <sup>5</sup>	Pulmonary vascular resistance
PVRI	DS/ m <sup>2</sup> /cm <sup>5</sup>	Pulmonary vascular resistance index
LCW	Kg.m	Left Cardiac work
LCWI	Kg.m/m <sup>2</sup>	Left Cardiac work index
LVSW	g.m	Left ventricular stroke work
LVSWI	g.m/ m <sup>2</sup>	Left ventricular stroke work index
RCW	Kg.m	Right Cardiac work
RCWI	Kg.m/m <sup>2</sup>	Right Cardiac work index
RVSW	g.m	Right ventricular stroke work
RVSWI	g.m/ m <sup>2</sup>	Right ventricular stroke work index
EF	%	Ejection fraction

## 19.6 Renal Function Calculation

### 19.6.1 Calculating Step

- 1, in the menu, select [calculate] → [Renal Cal.].
  - 2, enter the correct values for each parameter.
  3. Select the [calculate] button, you can calculate the value of each output parameter.
- For beyond the reasonable range of output value, which is shown as a yellow background. Now all parameters will disappear behind the unit, parameter out of range, reasonable range will be displayed.
  - [---] indicates an invalid value

### 19.6.2 Input Parameter

Abbreviation	Unit	English full name
URK	mmol/L	Urine potassium
URNa	mmol/L	Urinary sodium
Urine	ml/24h	Urine
Posm	mOsm/kgH <sub>2</sub> O	Plasm osmolality
Uosm	mOsm/kgH <sub>2</sub> O	Urine osmolality
SerNa	mmol/L	Serum sodium
Cr	μmol/L	creatinine
UCr	μmol/L	Urine creatinine
BUN	mmol/L	Blood urea nitrogen
Height	cm	Height
weight	Kg	weight

## 19.6.3 Output Parameter

Abbreviation	Unit	English full name
URNaEx	mmol/24h	Urine sodium excretion
URKEEx	mmol/24h	Urine potassium excretion
Na/K	%	Sodium potassium ratio
CNa	ml/24h	Clearance of sodium
Clcr	ml/min	Creatinine clearance rate
FENa	%	Fractional excretion of sodium
Cosm	ml/min	Osmolar clearance
CH <sub>2</sub> O	ml/h	Free water clearance
U/P osm		Urine to plasma osmolality ratio
BUN/Cr		Blood urea nitrogen creatinine ratio
U/Cr		Urine-serum creatinine ratio

## 19.7 MEWS System

- Open the Mean of the **【calculate】**, select **【MEWS System】** button to bring up the **【MEWS System】** menu. Menu display as follows:

The screenshot shows a software interface for the MEWS System. It features a title bar with the text 'MEWS System' and a close button (X). The main area contains several input fields and buttons:

- PR**: Input field with value 60.
- RESP**: Input field with value 20.
- NIBP(mmHg)**: Input fields for systolic and diastolic pressure, showing 120 and 80 respectively, separated by a slash (/).
- Temp(° C)**: Input field with value 36.0.
- Consciousness**: A button with the text 'Wide awake'.
- Start Score**: A large button below the Consciousness field.
- MEWS**: A label on the left side of the bottom section.
- Clear Data**: A button on the right side of the bottom section.
- Warning Process>>**: A button on the right side of the bottom section.

- Select **【Clear Data】** : Clear the entry of parameter values.
- Select **【Warning process】** :Open the view of the Warning process, Warning process default menu as shown below:

Warning Process		X
0~0	continue routine MEWS monitoring with every set of observations.	
1~3	Frequency of monitoring, minimum 4 hourly.	
4~6	Registered nurse to urgently inform the medical team caring for the patient within 30 minutes; Urgent assessment by a clinician with core competencies to assess acutely ill patients.	
7~14	Registered nurse to immediately inform the medical team caring for the patient, and this should be at least at Specialist Registrar level; Consider transfer of Clinical care to a level 2 or 3 care facility, i.e. higher dependency or ITU.	
3 in one parameter	Registered nurse to urgently inform the medical team caring for the patient; Increased frequency to a minimum of 1 hourly	

- Enter the appropriate HR, RESP, NIBP, TEMP measured values and states of consciousness. State of consciousness for the drop-down box, including four: wide awake, respond to voice, respond to pain, no response.
- Select **【start score】** :system start score automatically.

**MEWS System** ✕

PR	<input type="text" value="60"/>	<input type="text" value="0"/>
RESP	<input type="text" value="20"/>	<input type="text" value="1"/>
NIBP(mmHg)	<input type="text" value="100"/> / <input type="text" value="60"/>	<input type="text" value="1"/>
Temp(° C)	<input type="text" value="36.8"/>	<input type="text" value="0"/>
Consciousness	<input type="text" value="Wide awake"/>	<input type="text" value="0"/>

MEWS

**2**

# Chapter 20. Spot Check

## 20.1 Outline

This monitor provides spot metering function, you can measure the patient's heart rate, blood pressure, pulse rate, body temperature, oxygen, MEWS score, spot check data can be transmitted in a timely manner to the CMS.

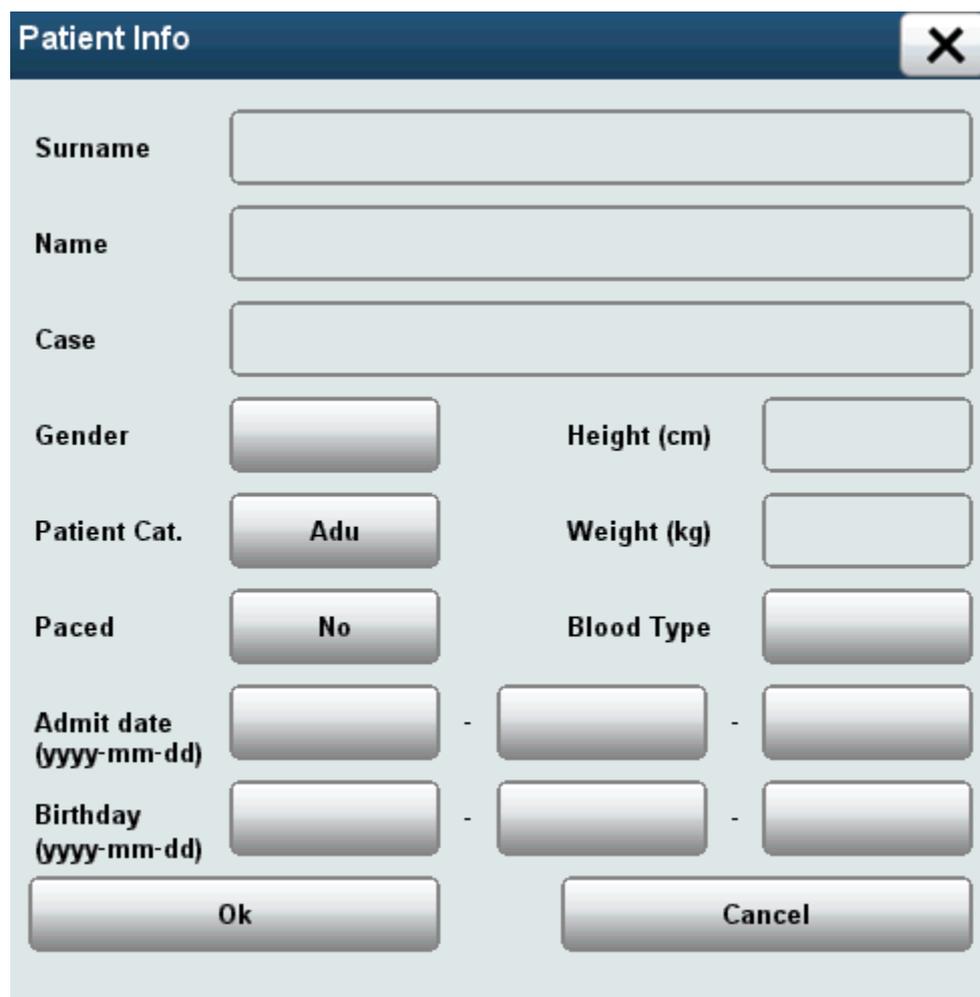
## 20.2 Set Point Measurement

The monitor can be set to continuous measurement and spot check measurement modes.

The monitor is set to the path spot check mode, **【Factory Maintenance】** → **【spot check】** → **【on】**, then it will open the spot check switch. **【mean】** → **【monitor type>>>】** will monitor type is set to spot check, click **【OK】**, the success of the monitor is set to spot check mode.

## 20.3 Use The Spot Check

Spot check mode is set up, will appear in the hotkey area measured point  , click the button to bring up the **【patient info】** menu, as shown below:



The image shows a 'Patient Info' dialog box with a close button (X) in the top right corner. The form contains the following fields and controls:

- Surname**: A text input field.
- Name**: A text input field.
- Case**: A text input field.
- Gender**: A dropdown menu.
- Height (cm)**: A text input field.
- Patient Cat.**: A dropdown menu with the value 'Adu' selected.
- Weight (kg)**: A text input field.
- Paced**: A dropdown menu with the value 'No' selected.
- Blood Type**: A dropdown menu.
- Admit date (yyyy-mm-dd)**: Three text input fields separated by dashes.
- Birthday (yyyy-mm-dd)**: Three text input fields separated by dashes.
- Ok**: A button at the bottom left.
- Cancel**: A button at the bottom right.

**【Surname】** : the patient's name

**【Name】** : the patient's name

**【Case】** : Patient Case number can not be empty, otherwise it will not be able to send data.

**【Gender】** : Male, female, other

**【Patient Cat.】** : adu, ped and neo

**【Paced】** : Yes, No

**【Height】** : the patient's height

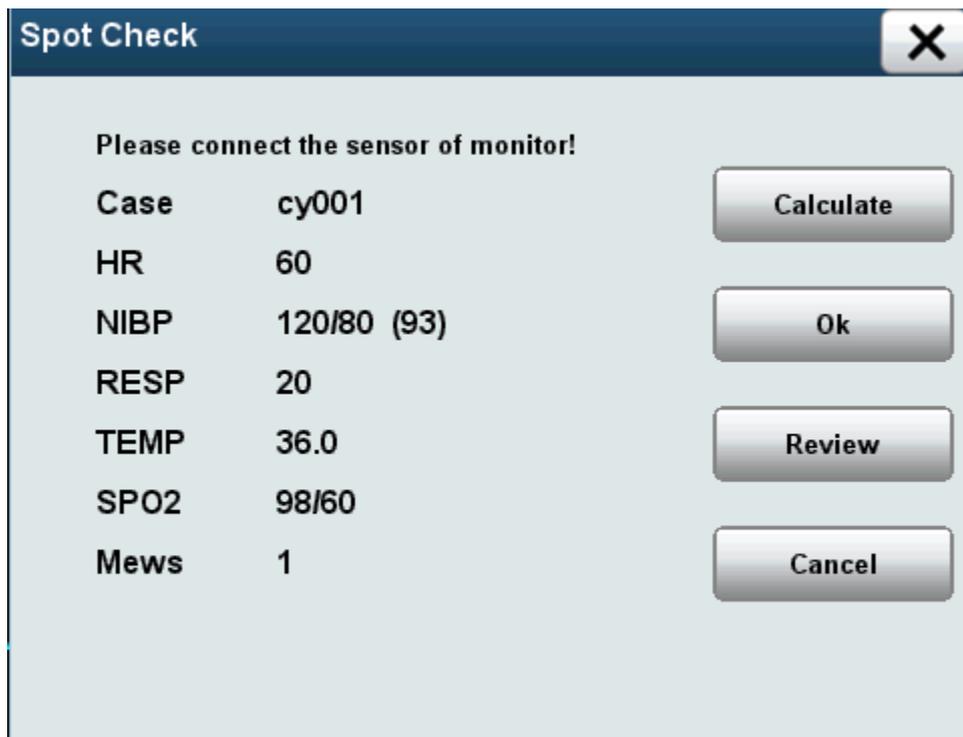
**【Weight】** : patient weight

**【Blood Type】** : A, B, AB, O

**【Admit date】** : Patient admission date

**【Birthday】** : Patient Date of Birth

Fill out patient information, click **【OK】** , the following interface pops up:



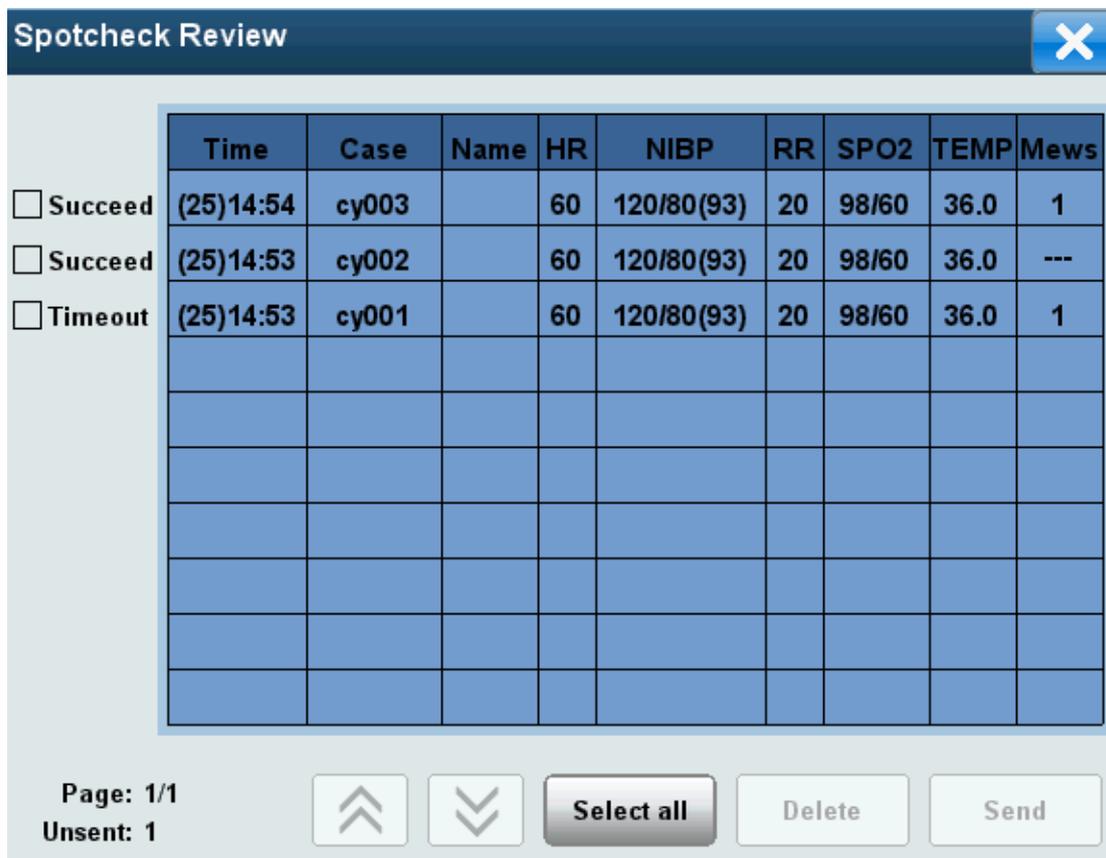
【Calculate】 : Calculate MEWS score

【OK】 : sending data to CMS

【Review】 : review patient information and measurement spot check View

【Cancel】 : Cancel the spot check data

The review of spot check window as shown below:



Select **【Select all】** , you can select all data in the current page.

Select **【Delete】** , you can delete the selected data.

Select **【Send】** , you can send data to the central station timeout.

You can select  and  button ,up or down to view the spotcheck review table.

# Chapter 21. Recording (optional)

## 21.1 Recorder Profile

The monitor adopt the thermal recorder, supports many recording Types, records patient information, trend graph/table data, up to three waveforms, etc.

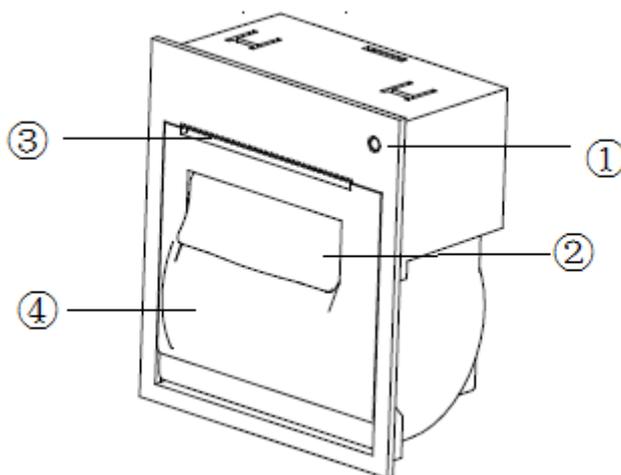


Fig. 20-1 Recorder

1. 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, jams, over heat, etc.
2. Wrench: Gently pull out the wrench, the printer will automatically open the doors
3. Paper outlet
4. Recorder door

The task-related recordings include:

- ◆ Real time recording
- ◆ 7-Lead waveforms recording
- ◆ Alarm trigger recording
- ◆ Frozen wave recording
- ◆ Graphic trends recording
- ◆ Tabular trends recording
- ◆ NIBP review recording
- ◆ Event review recording

## 21.2 Loading Paper

1. Pull out the wrench of the recorder, open the door.
2. Insert a new roll into the compartment with the recording side upward, make sure the paper end in the outside of paper outlet port.
3. Close the door of the recorder.
4. Check the position of the paper, make sure the paper aligned to the Recorder outlet.

### CAUTION

- Use only specified thermal paper. Otherwise, it may cause damage to the recorder's printer head, 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.
- If the recorder works incorrectly or produces unusual sounds, check if there is a paper jam first. If a paper jam is detected, open the recorder door, take out the paper and tear off the draped part, reload the paper and close the recorder door.

## 21.3 Setting up the Recorder

By selecting [Main Menu]→[Record Setup >>], you can access the [Record Setup] menu. As the following figure:

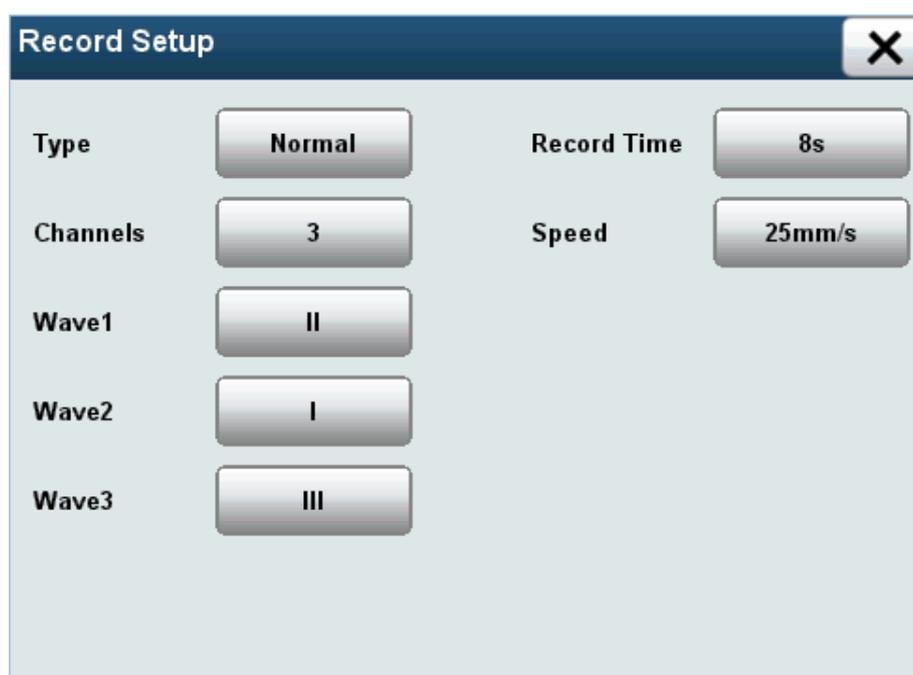


Fig. 20-2 Recorder setup

1. **[Types]**: normal type, 7-lead type can be setup.
  - ◆ Normal type **【conventional】** :The waveforms that you need to record can be setup in wave options.
  - ◆ 7-lead type **【7lead】** : Press record key, then 7-lead ECG can be record.
2. **【Trace】** :The trace of waveforms can be set up,3 traces or 2 traces. The wave type can be choose from wave option.
3. **【 Recording time】** :when start one real time record or alarm trigger, the record time is depend on your setting on the monitor.in the menu **【Record Setup】** →**[Record time >>]** can be set:
  - ◆ 8s/16s/32s: record 8-second waveforms from the current moment.
  - ◆ **[Continuous]**: record the waveforms from the current moment until stopped manually.
  - ◆ **【Recording Speed】** : In the [Record Speed] menu, select [Paper Speed] and toggle between [12.5 mm/s], [25 mm/s] and [50mm/s]. This setting is for all recordings containing waveforms.

## 21.4 Clearing Recorder

If the recorder has been used for a long time, deposits of paper debris may collect on the printhead compromising the print quality and shortening the lifetime of the roller. Follow this procedure to clean the printhead:

1. Take measures against the static electricity such as Disposable Wrist Strap for the work, Prevent electrostatic damage to the Recorder.
2. Open the recorder door and take out the paper, so as not to impede clean.
3. Gently wipe around the printhead using cotton swabs dampened with alcohol.
4. After the alcohol has completely been dried, reload the paper and close the recorder door.

### CAUTION

- Do not use anything that may destroy the thermal element, for example sandpaper.
- Do not add unnecessary force to the thermal head.

# Chapter 22. Battery

## 22.1 Checking Battery Performance

Please refer to the following steps to check the battery performance:

1. Disconnect the monitor from the patient and stop all monitoring or measurement.
2. Connect AC power to the monitor, and charge the battery for 10 hours uninterruptedly.
3. Disconnect the AC power and power the monitor with battery until the monitor is turned off.
4. Battery duration reflects the battery performance.

If the battery operating time is significantly shorter than the time stated in specifications, consider replacing the battery or contact our service personnel.

## 22.2 Overview

The monitor has a built-in rechargeable battery to ensure that the monitor can also be used normally in case of patient transfer or power failure. When the monitor is connected to an AC power source, it will charge the battery no matter whether the monitor is turned on or not. In the case of power failure, the system will automatically use the battery to power the monitor to avoid interrupting the monitor working.

The battery icon on the screen indicates the battery status:



Battery is working properly and is fully charged.



Battery is working properly and the green part indicates the battery power.



Battery power is low, and requires charging immediately, or else the monitor will turn off automatically.



Monitor battery is not installed.



Battery is properly installed and being charged.

The battery power can only maintain for some time. Low battery voltage will trigger a high level technical alarm [Battery Low]; in this case, connect the monitor to AC power and charge the battery.

## 22.3 Installing the battery

Before replacing the battery, please connect the monitor to an AC power supply or turn it off, to avoid monitoring being interrupted.

To install or replace the battery:

- Open the battery cover.
- Push aside the side battery stopper of the battery to be replaced and take out the battery.
- Keep the front side of the new battery (with printed text) downwards, interface toward the inside, insert it into the battery compartment, push back the battery stopper, and hold down the battery.
- Put on the battery cover.

## 22.4 Battery Usage Guide

Battery life depends on the frequency and time of use. If the battery maintenance and storage are proper, the lithium battery life is about three years. If you do not use the battery properly, its life may be shortened. It is recommended to replace the lithium battery once every three years.

In order to ensure the maximum capacity of the battery, please note the following usage guide:

- Before using the battery, please read the Operator's Manual and labels on the battery surface carefully.
- Do not drop the battery, and do not charge the battery in the charger for more than 24h.
- Before transporting the monitor or if the monitor won't be used over three months, please take out the battery.
- If it won't be used for a long time, please store the battery properly. Charge the battery to 50%, and wrap the battery with non-conductive material in order to avoid direct contact with metal, resulting in damage. Keep the battery in a cool dry place.
- Check the battery performance once every two years. Before servicing the monitor or you suspect that the battery is the fault source, also check the battery performance.



### **Warning**

- **Keep the battery out of the reach of children.**

- **Use only the designated battery.**
- **If the battery is damaged or leaks, replace it immediately. Do not use a defective battery for the monitor.**

## 22.5 Battery Recycling

If the battery has visible damage or cannot store power, it should be replaced and recycled properly. Follow the appropriate regulations to dispose of used batteries.



### **Warning**

- **Do not disassemble the battery, throw it in fire, or short-circuit it. Battery fire, explosion and leakage may lead to personal injury; do not directly touch the leaking battery.**

# Chapter 23. Caring and Cleaning

## 23.1 Overview

In the using process, please make sure that there is no dust on or near your device. To prevent damage, please use the diluted detergents and disinfectants specified in this Manual, and use the lowest possible concentration. For the damage or accident caused by using other materials or methods, manufacturer does not assume any responsibility.

## 23.2 Cleaning

The device should be cleaned regularly. In the heavily polluted environment, increase the frequency of cleaning. Before cleaning, please consult the hospital about device cleaning requirements.

Below are available cleaning agents:

- Diluted ammonia
- Diluted sodium hypochlorite (washing bleach)
- Diluted formaldehyde
- Hydrogen peroxide (3%)
- Ethanol (70%)
- Isopropanol (70%)

Before cleaning:

1. Turn off the monitor, disconnect the power cord and remove the battery.
2. Use a soft cotton ball to adsorb appropriate amount of cleaning agent and wipe the display screen.
3. Use a soft lint-free cloth to adsorb appropriate amount of cleaning agent and wipe the surface of the device.
4. If necessary, use a clean, dry, lint-free cloth to remove any excess detergent.
5. Dry the device naturally in a ventilated cool environment.

 **Warning**

- **Before cleaning the monitor or sensor, turn off the power and disconnect the AC power.**
- **The monitor should be kept clean. It is recommended to regularly clean the enclosure surface and the display screen. Cleaning the enclosure with non-etching cleaners such as soap and water.**

 **Caution**

- **To avoid damaging the monitor:**
  - ✧ **Do not use strong solvents such as acetone.**
  - ✧ **Most cleaners must be diluted before use. Dilute according to the manufacturer's instructions.**
  - ✧ **Do not use abrasive materials (such as steel wool).**
  - ✧ **Do not allow any liquid entering into the enclosure, and never immerse any part of the device into liquid.**
  - ✧ **Do not leave any cleaning solution on the surface of any part of the device.**

**Notes**

- **Wipe the monitor and sensor surface with medical alcohol, dry it naturally or with clean, dry, lint-free cloth.**
- **Manufacturer is not liable for effectiveness of using these chemicals for infectious disease control. Please consult the infectious disease control officers or experts of the hospital for advice.**

## 23.3 Disinfection

In order to avoid damage to the product, we recommend that the product is disinfected only when it is deemed necessary by the hospital maintenance procedures. We also recommend that the instrument to be disinfected must first be cleaned.

 **Caution**

- **To prevent damage to the monitor, do not disinfect the monitor with gas (EtO) or formaldehyde.**

## 23.4 Sterilization

In order to avoid long-term damage to the device, we recommend that the product is sterilized only when it is deemed necessary by the instrument maintenance program. We also recommend that the instrument to be sterilized must first be cleaned.

Sterilization materials recommended for the monitor: ethanol group, aldehyde group.



### Caution

- Dilute or use concentration as low as possible according to the manufacturer's instructions.
- Do not let liquid enter into the enclosure.
- Never immerse any part of the instrument.
- Do not pour liquid onto the instrument in the sterilization process.
- Do not leave any fungicide residues on the surface of the device; clean it immediately with a damp cloth.

# Chapter 24. Maintenance



## Warning

- **If the hospitals or institutions using this instrument can't implement a satisfactory maintenance schedule, it will result in device failure and may endanger human health.**

## 24.1 Checking

Check the following basic items before using the monitor:

- Check for any mechanical damage;
- Check all exposed wires, insertions and accessories;
- Check all instrument functions that may be used for patient monitoring and ensure that the instrument is in good working condition.

If the instrument function has any sign of damage, do not use this monitor for any patient monitoring. Please contact the hospital's professional maintenance personnel or our customer service personnel.

Every 6-12 months or after each repair, a comprehensive examination must be performed by trained and qualified technical service personnel, including functional safety checks; the specific inspection items are as follows:

- Environment and power meet the requirements.
- Device and accessories have no mechanical damage.
- The power supply has no wear, and the insulation is good.
- Specified accessories are used.
- Alarm system is functioning correctly.
- Battery performance meets the requirements.
- Monitoring functions are in good working condition.
- Ground impedance and leakage current meet the requirements.

If the instrument function has any sign of damage, do not use this monitor for any patient monitoring. Please contact the hospital's professional maintenance personnel or our customer service personnel.

All checks that require disassembling the instrument must be performed by qualified service personnel. Safety and maintenance checks may also be carried out by the Company's personnel.

## 24.2 Viewing Software Version Info

You can view the software version through the following steps:

- Select  [Menu] Smart Hotkey→[Main Menu];
- Select [Monitor Information >>] → [Monitor Info] menu;
- [Monitor Info] menu displays the software version information of the monitor.

The software version of the monitor: V1.1.7

## 24.2 Maintenance Plan

The following tasks can only be done by qualified service personnel of manufacturer. When the following maintenance is needed, please contact your service representative. Before testing or maintenance, clean and disinfect the device.

Inspection / Maintenance Item	Frequency
Check the safety according to IEC 60601-1	At least once every two years, after replacing the power supply or the monitor falls down.
Check all monitoring or measuring functions not listed	At least once every two years, or when you suspect that the measured value is not accurate.
NIBP leakage test	At least once every two years, or follow hospital regulations
NIBP calibration	At least once every two years, or follow hospital regulations

## 24.3 ECG Calibration

In the process of using the monitor, the displayed ECG signals may be inaccurate due to hardware or software problems, mainly shown as waveform amplitude becoming larger or smaller. At this moment, you need to calibrate ECG.

Prepare the following instruments before testing:

- ECG simulator
- ECG cable
- Vernier caliper

The calibration method is as follows:

- Connect the ECG cable to the monitor.
- Connect the ECG electrodes to the ECG simulator.
- Select  [Menu] Smart Hotkey→[Main Menu];
- Select [User Maintenance >>] →enter the password and confirm → [User Maintenance] menu;
- Select [Module Maintenance >>] → [Module Maintenance] menu;
- Select [ECG >>] → [ECG Maintenance] menu, and select [Calibration] to calibrate the ECG;
- Measure the wave amplitude with a caliper; in different filtering modes, X0.25 is  $2.5 \pm 5\%$  (mm), X0.5 is  $5.0 \pm 5\%$  (mm), X1 is  $10.0 \pm 5\%$  (mm), and X2 is  $20.0 \pm 5\%$  (mm). Comparing the amplitude of the square wave with the ruler, the error range should be within 5%;
- When calibration is complete, select [Stop Calibration] to exit.

## 24.4 Touch Screen Calibration

You can follow the steps below to complete the calibration of the touch screen:

- Select  [Menu] Smart Hotkey→[Main Menu];
- Select [User Maintenance >>] →enter the password and confirm → [User Maintenance] menu;
- Select [Cal. Touchscreen] to enter the touch screen calibration interface.
- Click on the screen and the alignment mark appears in different positions.
- If the touch screen calibration is finished after clicking three times, select [Ok] to exit the

calibration interface; if the touch screen isn't completely calibrated, select [Retry] for re-calibration.

## 24.5 CO2 Calibration

Sidestream ISA module does not required regular calibration, and users can calibrate the Sidestream module every 1 year if needed or when the measured deviation get too large.

Gas requirements in calibration:

Maintenance Master software.

CO2 concentration: 4%-11%

Oxygen concentration: 45%-100%

All the gas must meet the precision:  $\pm 0.03$  vol% or  $\pm(0.02 \text{ vol\%} + \text{reading's } 0.1\%)$ , and pick the higher value.

Steps of calibration go as follows:

1. Connecting the new Nomoline sampling tube to ISA gas analyzer.
2. Warm up for at least 1 minute.
3. Press "Pre span calibration zeroing" to ensure that the air surrounding gas is normal (21%O2 and 0% CO2).
5. Open **【Main Menu】** -> **【User Maintenance】** -> **【Module Maintenance】** -> **【CO2 Maintenance】**, set the value in the **【CO2 Calibration】** to the same value with the input gas concentration.
6. when the measured CO2 concentration gets stable, click the **【CO2 Maintenance】** - **【CO2 Calibration】** button.
7. Check the CO2 parameter area to see if the gas reading is consistent with the measured CO2 concentration after the gas scale calibration is completed.

## 24.6 AG Calibration

Sidestream ISA AG module does not required regular calibration, and users can calibrate the ISA AG Sidestream module every 1 year if needed or when the measured deviation get too large. IRMA mainstream module does not require calibration.

Gas requirements in calibration:

Maintenance Master software

CO2 concentration: 4%- 11%

Oxygen concentration: 45%-100%

Nitrous Oxide: 30%-100%

AA: TBD

All the gas must meet the precision:  $\pm 0.03$  vol% or  $\pm(0.02 \text{ vol\%} + \text{reading's } 0.1\%)$ , and pick the higher value

Steps of calibration go as follows:

1. Connecting the new Nomoline sampling tube to ISA gas analyzer.
2. Warm up for at least 1 minute.
3. Press "Pre span calibration zeroing" to ensure that the air surrounding gas is normal (21%O<sub>2</sub> and 0% CO<sub>2</sub>).
4. Supplying the calibration gas and wait at least 30 seconds
5. open **【Main Menu】**->**【User Maintenance】**->**【Module Maintenance】**->**【AG Maintenance】**, set the value in **【CO<sub>2</sub> Calibration】**, **【O<sub>2</sub> Calibration】**, **【N<sub>2</sub>O Calibration】** and **【AA Calibration】** same with the input gas concentration ; it is no need to set other items when using one type of gas.
6. when the concentration of measured gas gets table, press **【AG Maintenance】** - **【CO<sub>2</sub> Calibration】**, **【O<sub>2</sub> Calibration】**, **【N<sub>2</sub>O Calibration】**, **【AA Calibration】**
7. Check the parameter areas to see if the gas reading is consistent with the measured CO<sub>2</sub> concentration after the gas scale calibration is completed.

## Chapter 25. Accessories



### Warning

- Use the accessories specified in the Operator's Manual; using other accessories may damage the monitor, or cannot reach the performance claimed in this Manual.
- The operating and storage environment of the monitor should meet the requirements of the accessories. Please refer to the manual of the accessories for these requirements.
- Disposable accessories can only be used once, because repeated use can cause performance degradation.
- If the packaging or accessories have any sign of damage, do not use such accessories.

### 25.1 Standard Accessory List

Standard accessories are as follows:

No.	Name	Specifications & characteristics	Standard quantity
1	5-lead ECG cable	Adult 5-lead all-in-one clip	1
2	Electrode slice	50mm×55mm, adult, disposable	1
3	Oxygen probe	Adult finger clip	1
4	Blood pressure cuff	Adult repetitive single-tube cuff	1
	Blood pressure gas nozzle	Metal	1
	Blood pressure extension tube	3M gray	1
5	2.25K-type temperature probe	Adult body surface	1
6	2600mAh lithium battery	Detachable three-cell lithium battery (14.8V 2600mAh)	1
7	Ground wire	V0020A	1

No.	Name	Specifications & characteristics	Standard quantity
8	Power cord	3×0.75mm <sup>2</sup> 10A 250V L=2M	1

## 25.2 ECG

12-pin integrated 5-lead left/right clamp ECG cable

Supported lead wires	Symbol standard	Type	Applicable objects	Length (main cable)	Length (5-lead ECG cable)
3/5-lead wire	IEC	Defibrillation type	Adult	2.7m	0.9m

## 25.3 SpO<sub>2</sub>

Adult finger clip oxygen probe

Applicable objects	Applicable parts	Type	Length
Adult	Fingers, toes	Reusable	3m

## 25.4 NIBP

1. Blood pressure cuff

Applicable objects	Applicable parts	Type	Remark
Adult	Arm or thigh	Reusable	Single-tube

## 2. Blood pressure gas nozzle

Operating temperature	Applicable parts	Mechanical life (connecting and disconnecting)	Remark
-30°C~+60°C	Blood pressure cuff	> 1000 times	Pull-off force of gas connector and extension tube is greater than 5kg

## 3. Blood pressure extension tube

Applicable objects	Type	Length	Remark
Adult, child	Reusable	3m	Used together with cuff

## 25.5 Temp

## 2.25K-type temperature probe

Applicable objects	Applicable parts	Type	Length
Adult	Body surface	Reusable	3m

## Chapter 26. Residual Risks

CETUS x12 / x15 Multi-Parameter Patient Monitor is a kind of monitoring instrument, which monitors patients, and measures such as ECG, non-invasive blood pressure, oxygen saturation, body temperature, respiration and pulse rate. According to the requirements and regulations of ISO 14971:2016, the risk of this product is analyzed, and the predicted analysis results are risk-free.

The following residual risks for patients, users and third parties have been identified within the risk management process:

- Safety risks due to inadequate service and maintenance tasks and intervals.
- Safety risks due to inadequate transport processes and materials.
- Safety risks by using the device by unqualified staff and misunderstanding the product and documentation.
- Safety risks by electric shock while using the patient monitor being electrically connected to patients, users and third parties (e.g. ECG).

Please be aware of these risks by using the patient monitor. In order to minimize these risks, the operator has to take care of checking the device before using and in intervals according manufacturer requirements. Also, that the materials and tools for transport and installation are suitable and approved by the manufacturer.

The staff using this product and make decisions related to patient's health need to be qualified and has to understand the product in function and features.

Risks by electric shock can be minimized by using tested and approved accessories and regular electrical safety testing by authorized staff after installation, before using and during lifetime of the product.

# Appendix A Specifications

## A.1 Safety Specifications

### A.1.1 Product Category

In accordance with classification specified in the European Medical Device Directive 93/42/EEC, this monitor is IIB type equipment. The monitor is classified as follows in accordance with IEC 60601-1:

Category Name	Specification
93/42/EEC ohm Medical Devices Directive Category	IIB
Type of electric shock protection	Grade I, internal and external power supply equipment  When you question the integrity of the external protective earthing or protective ground conductor parameter of the equipment, the device must be powered by the internal power supply (battery).
Electric shock protection grade	ECG/NIBP/SpO2/PR/TEMP/RESP: CF (defibrillation protection)
Explosion protection grade	Common equipment, no explosion protection
Liquid inlet protection grade	IPX1 (prevent water from entering when the water drips vertically)
Operating mode	Continuous
Movement	Portable

### A.1.2 Power Specifications

Parameter	Specification
External AC power	
Input voltage	100-240V~
Input current	1.0-0.5A
Frequency	50/60Hz
Fuse	T1.6A 250V

Internal power supply: Lithium-ion battery	
Rated battery voltage	d.c. 14.8V
Battery capacity	2600 or 4800mAh
Maximum supply time	About 5 hours (4800mAh)
Charging time	About 6 hours in power on state
Minimum supply voltage	10.5V

## A.2 Hardware Specifications

### A.2.1 Physical Specifications

Dimensions	12.1 inch	310×285×166mm (L×W×T)
	15.6 inch	398×302×185mm(L×W×T)
Weight	< 10kg under standard configuration	

### A.2.2 Display

Host Monitor	
Type	Color TFT LCD
<b>Size</b>	<b>Resolution</b>
12.1 inch	800×600 pixels
15.6 inch	1366×768 pixels

### A.2.3 Host LED

Alarm indicator	1 (yellow / red)
AC power indicator	1 (white)
Battery status indicator	1 (white)

### A.2.4 Audio Instruction

Speaker	Alarm sound (45 ~ 85dB), key-pressing sound、QRS sound, PR sound. Alarm sounds meet IEC 60601-1-8 standard.
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## A.2.5 Alarm Signal

Alarm delay	Off or 1s, 2s, 3s, 4s, 5s, 6s, 7s, 8s; depending on the configuration; the default is 4s.
Pause duration	1min, 2min, 3min, 4min, 5min, 10min, 15min or infinite; depending on the configuration; the default is 2min.

## A.3 Data Storage

Trend data	Long trend: 120h, minimum resolution: 1min
	Short trend: 1h, minimum resolution: 1s
Parameter alarm event	200 parameter alarm events
NIBP measurement results	1000 groups

## A.4 Measurement Specifications

### A.4.1 ECG/TEMP/RESP Specifications

ECG Specifications		
Standards compliant	EN 60601-2-27/IEC 60601-2-27, GB 9706.25, IEC60601-2-25	
Lead type	3-lead	I, II, III
	5-lead	I, II, III, aVR, aVL, aVF, V
Display sensitivity	2.5mm/mV ( $\times 0.25$ ), 5mm/mV ( $\times 0.5$ ), 10mm/mV ( $\times 1.0$ ), 20mm/mV ( $\times 2.0$ )	
Wave sweep speed	6.25mm/s, 12.5 mm/s, 25 mm/s, 50 mm/s	
Bandwidth	Diagnostic mode	0.05Hz~100Hz
	Monitor mode	0.5Hz~40Hz
	Surgery mode	1Hz~20Hz
	Strong filter mode	5Hz~20Hz
CMRR	>100dB	
Notch	50/60Hz notch filter can be set to on or off	
Differential input impedance	>5M $\Omega$	
Electrode polarization voltage range	$\pm 400$ mV	
Baseline recovery time	<3s after defibrillation (in monitor and surgery mode)	
Calibration signal	1mV (peak - peak), accuracy $\pm 3\%$	

Pacing pulse		
Pulse identification	For PACE pulses that meet the criteria below, PAEC will be marked on the screen: Detection range: $\pm 4$ mv ~ $\pm 700$ mv Pulse width: 0.2ms ~ 2.0ms	
Average HR	Calculate from 15s data	
Interval of HR refreshing	Calculate once every second	
HR change response time	Time from 80bpm to 120bpm: $\leq 10$ sec Time from 80bpm to 40bpm: $\leq 10$ sec	
Tall T-wave suppression	For T-wave with 100ms QRS wave, 350ms QT period, 180ms duration and 1.2mV amplitude, the HR calculation won't be affected	
<b>Alarm specifications</b>	<b>Range (bpm)</b>	<b>Step (bpm)</b>
HR upper limit	Adult: 16~300	1
	Pediatric/Neonate: 16~350	
HR lower limit	Adult: 15~299	
	Pediatric/Neonate: 15~349	

<b>HR</b>		
Measuring range	3/5-lead monitoring	Adult: 15bpm~300bpm
		Pediatric/Neonate: 15bpm~350bpm
Resolution	1bpm	
Heart rate measurement error	±1bpm or ±1%, whichever is greater	

<b>TEMP</b>		
Standards compliant	EN12470-4, ISO 80601-2-56	
Measurement method	Thermistor	
Measuring range	5~50°C (41~122°F)	
Resolution	0.1°C	
Measurement accuracy	±0.1°C	
Number of channels	Two	
<b>Alarm specifications</b>	<b>Range</b>	<b>Step</b>
T1/T2 upper limit	0.1°C~50.0°C	0.1°C 0.1°F
T1/T2 lower limit	0°C~49.9°C	
TD upper limit	0~50°C	

<b>RESP</b>	
Measurement method	Thoracic electrical bioimpedance method
Measuring lead	Lead I, II
Wave gain	×0.25, ×0.5, ×1, ×2
Respiratory impedance range	0.5-5Ω
Baseline impedance	500-4000Ω
Gain	10 grades
Scan speed	6.25mm/s, 12.5 mm/s, 25mm/s

#### A.4.2 NIBP Specifications

Standards compliant	EN 60601-2-30/IEC 60601-2-30, EN 1060-1, EN 1060-3, EN1060-4 EN/IEC 60601-1.
Measurement method	Automatic oscillometric method
Operating mode	Manual, automatic, continuous
Useful life	100, 000 times
Measurement interval in automatic mode	1/2/3/4/5/10/15/30/60/90/120/180/240/480min

Typical measurement time	20~40s			
Normal mode measuring range (mmHg)		Adult	Pediatric	Neonatal
	Systolic blood pressure	40-270	40-200	40-135
	Mean blood pressure	20-230	20-165	20-120
	Diastolic blood pressure	10-210	10-150	10-100
Measurement accuracy	Maximum average error: $\pm 5$ mmHg Maximum standard deviation: 8mmHg			
Resolution	1mmHg			
Initial inflation pressure		Default	Pressure setting range	
	Adult	150mmHg	80~240mmHg	
	Pediatric	100mmHg	80~200mmHg	
	Neonatal	100mmHg	60-120mmHg	
Overpressure protection point (software)	Adult: 300mmHg Pediatric: 240mmHg Neonatal: 150mmHg			
Overpressure protection point (hardware)	Adult: 320~330mmHg Pediatric: 265~275mmHg Neonatal: 160~165mmHg			
Pressure accuracy	$\pm 3$ mmHg			
Electrical characteristics				
Supply voltage	10V~14V DC			
Maximum power consumption	3.6w			
Quiescent current	50mA			
Maximum current during measurement	180mA			
Maximum current during inflation	300mA			

### A.4.3 SpO2 Specifications

Standards compliant	ISO 80601-2-61
Display range	0%~100%
SpO2 display resolution	1%
SpO2 checking accuracy	2% (70%~100%); not define when lower than 70%

SpO2 alarm preset limits	Upper alarm limit	1%~100%
	Lower alarm limit	0%~99%
SpO2 alarm preset accuracy	±1%	
SpO2 alerting signal generates a delay	No delay	
SpO2 value refresh period	1s/time	
SpO2 value refresh delay	< 10s	
Average period	Low sensitivity	7~8s
	Intermediate sensitivity	4~6s
	Advanced sensitivity	2~3s
Alarm condition delay period	Low sensitivity	<8s
	Intermediate sensitivity	<6s
	Advanced sensitivity	<3s
Alarm sign generates delay period	0s	
<b>PR</b>		
Measuring range	30~254bpm	
Resolution	1%	
Accuracy	±2% or ±2bpm	

#### A.4.4 IBP specification

Required standard	IEC60601-2-34/EN 60601-2-34	
Measurement method	invasive blood testing	
<b>IBP specification</b>		
Range	-30~300mmHg	
Resolution	1mmHg	
Accuracy	±1mmHg or 2%, whichever is greater ( not contain sensor error)	
renewal period	1 s	
Zero adjustment	Range	±200mmHg
	Accuracy	1 mmHg
	Temp range	0.1 mmHg/°C
Waveform	2or 4 channels	
Zeroing range	± 200mmHg	
<b>PR</b>		
Range	30~280 bpm	
Resolution	1bpm	
Accuracy	±2bpm	
<b>Pressure transducer</b>		
Voltage	5±5% (VDC)	
Power Consumption	小于 1 W	
Sensitivity	5uV/V/mmHg	
Input impedance	300~3000(Ohm)	
<b>Working environment</b>		
Operating temperature	0~60°C	
Operating Humidity	15%~90%	
Air pressure	428mmHg~760mmHg(0~1572 米)	

### A.4.5 C.O. Specification

Measurement method	thermodilution	
Range	C.O.	0.20~20.00L/MIN
	TB	23.0~45.0°C
	TI	-1.0~27.0°C
Resolution	C.O.	0.01L/MIN
	TB	0.1°C
	TI	
Accuracy	C.O.	±5%
	TB	±0.5°C
	TI	

### A.4.6 BIS Specification

type	BISx
BIS measurement range	0~100
Signal quality index (SQI) range	0~100%
EMG range	0~100dB
rejection ratio (SR)	0~100%
spectral edge frequency (SEF)	0.5~30.0HZ
Total paroxysmal (BC)	0~30/min
noise	<0.3uV RMS (2.0uV top-top)
Update frequency	<1s
bandwidth	0.25~100HZ(-3dB)
high-pass filter	0.25HZ、1HZ、2HZ(-3dB)
low pass filter	30HZ、50HZ、70HZ、100HZ(-3dB)
Notch Line filter (frequency)	50HZ、60HZ
Impedance measurement range	0~999KΩ

## Appendix B EMC

This product complies with EN 60601-1-2 Medical Electrical Equipment - Part 1-2: General requirements for safety - Collateral standard electromagnetic compatibility requirements and tests

### Notes:

- **Using unqualified accessories, sensors and cables will increase the electromagnetic emission and reduce the electromagnetic immunity of the device.**
- **Do not put the device close to other devices or stack together. When necessary, observe the device closely to ensure that it runs normally in the environment.**
- **The device requires special EMC protection, and it is necessary to install and maintain it in the environment that meets the following EMC information.**
- **Even if other devices comply with CISPR emission requirements, they may also cause interference to this device.**
- **When the input signal amplitude is smaller than the minimum amplitude specified in the technical specifications, it may result in inaccurate measurements.**
- **Mobile communication devices or wireless network devices may have an impact on the device.**

<b>Electromagnetic Emission Guidelines and Declarations</b>		
Patient Monitor should be used in the specified electromagnetic environment. The user should ensure that the device is used in the following electromagnetic environment.		
<b>Emission test</b>	<b>Compliance</b>	<b>Electromagnetic environment - Guide</b>
RF emission CISPR11	Group 1	The device uses radio frequency energy only when the internal function is running, and thus its RF emission is very low, and won't cause electromagnetic interference to nearby electronic equipment.
RF emission CISPR11	ClassA	This device is suitable for the public low-voltage power supply network that isn't connected to residence directly.
Harmonic emission IEC 61000-3-2	ClassA	
Voltage fluctuations and flicker IEC 61000-3-3	Conform	

<b>Guidance and Declaration - Electromagnetic Immunity</b>			
Patient Monitor is suitable for use in the electromagnetic environment specified below. The customer or the user of the device should assure that it is used in such an environment.			
<b>Immunity</b>	<b>test IEC60601 test level</b>	<b>Compliance level</b>	<b>Electromagnetic environment - guidance</b>
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 I/O for input/output lines (>3 m)	±2 kV for power supply lines ±1 kV I/O for input/output lines (>3 m)	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 differential mode ±2 kV common mode	
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5 % UT (>95 % dip in UT) for 0.5 cycle  40 % UT (60 % dip in UT) for 5 cycles  70 % UT (30 % dip in UT) for 25 cycles  <5 % UT (>95 % dip in UT) for 5 s	<5 % UT (>95 % dip in UT) for 0.5 cycle  40 % UT (60 % dip in UT) for 5 cycles  70 % UT (30 % dip in UT) for 25 cycles  <5 % UT (>95 % dip in UT) for 5 s	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.
Note: UT is the AC mains voltage prior to application of the test level.			

<b>Guidance and Declaration - Electromagnetic Immunity</b>		
Patient Monitor is suitable for use in the electromagnetic environment specified below. The customer or the user of the device should assure that it is used in such an environment.		
<b>Immunity test</b>	<b>IEC 60601 Test level</b>	<b>Compliance level</b>
Conducted RF IEC61000-4-6	3 Vrms 150k to 80M Hz	3 Vrms
Radiated RF IEC61000-4-3	3V/m 80M to 2.5G Hz	3V/m
<b>Electromagnetic environment - guidance</b>		
<p>Portable and mobile RF communications equipment should be used no closer to any part of the device, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.</p> <p>Recommended Separation Distance:</p> $d - 1.2\sqrt{p} \quad (d - 3.5\sqrt{p})$ $d - 1.2\sqrt{p} \quad (\text{Resp: } d - 3.5\sqrt{p}) \quad 80 \text{ to } 800\text{MHz}$ $d - 1.2\sqrt{p} \quad 800\text{M to } 2.5\text{GHz}$ <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 symbol: </p>		
<p>Note 1: From 80 MHz to 800 MHz, the higher frequency range applies.</p> <p>Note 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.</p>		
<p><sup>a</sup> 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 device is used exceeds the applicable RF compliance level above, the device should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the device.</p> <p><sup>b</sup> Over the frequency ranges 150kHz to 80MHz, field strengths should be less than 3V/m.</p>		

<b>Recommended Separation Distances between Portable and Mobile RF Communications Equipment and The device</b>			
The device is suitable for use in an electromagnetic environment in which radiated RF disturbance are controlled. The customer or the user of the device can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the device as recommended below, according to the maximum output power of the communication equipment.			
<b>Rated Maximum Output power of Transmitter Watts (W)</b>	<b>Separation Distance Meters (m) Corresponding to Frequency of Transmitter</b>		
	150k to 80MHz	80M to 800MHz	800M to 2.5GHz
	$d=3.5\sqrt{p}$	$d=3.5\sqrt{p}$	$d=\left[\frac{7}{3}\right]\sqrt{p}$
0.01	0.35	0.35	0.23
0.1	1.11	1.11	0.74
1	3.5	3.5	2.34
10	11.07	11.07	7.38
100	35	35	23.24
For transmitters at a maximum output power not listed above, the separation distance can be estimated using the equation in the corresponding column, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer. Note 1: From 80 MHz to 800 MHz, the separation distance for the higher frequency range applies. Note 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			

## Appendix C Alarm Information

This chapter lists some important physiological and technical alarm information, and some alarms are not necessarily listed.

Note that in this chapter: L column indicates the default alarm level: H indicates high level, M indicates middle level, L indicates low level, and “\*” indicates level set by the user.

Corresponding countermeasures are listed for each alarm message. If you operate in accordance with the countermeasures but the problem persists, contact your service personnel.

### C.1 Physiological Alarm Information

Source	Alarm message	L	Causes and countermeasures
ECG	HR Too High	M*	HR value is higher than the upper alarm limit or lower than the lower alarm limit. Check the patient's physiological condition, and check if the patient category and alarm limit settings are appropriate for the patient.
	HR Too Low		
	PVCS Too High	M*	PVCs value is higher than the upper alarm limit or lower than the lower alarm limit. Check the patient's physiological condition, and check if the patient category and alarm limit settings are appropriate for the patient.
	Asystole	H	The patient has arrhythmia. Check the patient's condition, electrodes, cables and lead wires.
	VF/VTA	H	
	R on T	M*	
	Frequent PVC	M*	
	Couplet PVC	M*	
	Single PVC	M*	
	PVC Bigeminy	M*	
	PVC Trigeminy	M*	
	Tachycardia	M*	
Bradycardia	M*		
Miss Beat	M*		

Source	Alarm message	L	Causes and countermeasures
	Pacemaker Not Capture	H	Pacemaker works abnormally; check the pacemaker.
	Pacemaker Not work	H	
	ECG Signal weak	H	The patient ECG signal is too weak, and the system can't analyze. Check the patient's condition, electrodes, cables and leads.
	ST-I Too High	M*	ST value is higher than the upper alarm limit or lower than the lower alarm limit. Check the patient's physiological condition, and check if the patient category and alarm limit settings are appropriate for the patient.
	ST-I Too Low		
	ST-II Too High		
	ST-II Too Low		
ST-III Too High			
ST-III Too Low			
Resp	RR Too High	M*	Patient PR value is higher than the upper alarm limit or lower than the lower alarm limit. Check the patient's physiological condition, and check if the patient category and alarm limit settings are appropriate for the patient.
	RR Too Low		
	Apnea(Resp)	H	The patient's respiratory signal is too weak, and the system can't analyze. Check the patient's condition, electrodes, cables and leads.
	RESP ARTIFACT	H*	Respiration heartbeat interference
Temp	T1 Too High	M*	T1/T2 value is higher than the upper alarm limit or lower than the lower alarm limit. Check the patient's physiological condition, and check if the patient category and alarm limit settings are appropriate for the patient.
	T1 Too Low		
	T2 Too High		
	T2 Too Low		
	TD Too High		TD value is higher than the upper alarm limit or lower than the lower alarm limit. Check the patient's physiological condition, and check if the patient category and alarm limit settings are appropriate for the patient.
SpO2	SPO2 Too High	M*	SpO2 value is higher than the upper alarm limit or lower than the lower alarm limit. Check the patient's physiological condition, and check if the patient category and alarm limit settings are appropriate for
	SPO2 Too Low		

Source	Alarm message	L	Causes and countermeasures
			the patient.
	PR Too High		
	PR Too Low		
NIBP	NIBP signal weak	M*	NIBP value is higher than the upper alarm limit or lower than the lower alarm limit. Check the patient's physiological condition, and check if the patient category and alarm limit settings are appropriate for the patient.
	NIBP-Sys Too High		
	NIBP-Sys Too Low		
	NIBP-Mean Too High		
	NIBP-Mean Too Low		
	NIBP-Dia Too High		
IBP	Art-Sys too high	M*	ArtSys value has risen above the high alarm limit or fallen below the low alarm limit. Check the patient's condition and check if the patient category and alarm limit settings are correct.  The other entitles corresponding pressure exceed the limit in the same way.
	Art-Sys too low	M*	
CO2	EtCO2 too high	M*	CO2 value has risen above the high alarm limit or fallen below the low alarm limit. Check the patient's condition and check if the patient category and alarm limit settings are correct.
	EtCO2 too low	M*	
			The patient stops breathing, or the respiration signal was so weak that the monitor cannot perform respiration analysis. Check the patient's condition and the RM connections.
	FiCO2 too high	M*	
	AWRR too high	M*	
	AWRR too low	M*	
	CO2 Apnea	H	
AG	EtCO2 too high	M*	CO2、N2O、O2 value has risen above the high alarm limit or fallen below the low alarm limit. Check the patient's condition and check if the patient category and alarm limit settings are correct.
	EtCO2 too low	M*	
	FiCO2 too high	M*	
	AwRR too high	M*	
	AWRR too low	M*	
	EtN2O too high	M*	

Source	Alarm message	L	Causes and countermeasures
	EtN2O too low	M*	
	FiN2O too high	M*	
	FiN2O too low	M*	
	EtO2 too high	M*	
	EtO2 too low	M*	
	FiO2 too high	M*	
	FiO2 too low	M*	
	EtAA too high	M*	AGAA(AA include: HAL、DES、ISO、SEV、ENF) value has risen above the high alarm limit or fallen below the low alarm limit. Check the patient's condition and check if the patient category and alarm limit settings are correct.
	EtAA too low	M*	
	FiAA too high	M*	
FiAA too low	M*		
	AG Apnea	H	The patient stops breathing, or the respiration signal was so weak that the monitor cannot perform respiration analysis. Check the patient's condition and the RM connections.
C.O.	TB too high	M*	The blood temperature is too high, reduce the injection temperature.
	TB too low	M*	The blood temperature is too low, increase injection temperature, or to reduce the frequency of intra-articular injections of saline solution
BIS	BIS too high	M*	Patient with clear consciousness than expected, Adjust narcotic injection quantity.
	BIS too low	M*	Patients with low degree of consciousness than expected, adjust narcotic injection quantity.

## C.2 Technical Alarm Information

Source	Alarm message	L	Causes and countermeasures
System	Battery Low	H	Connect to AC power supply, and charge the battery, and power with the battery as needed after fully charged.
ECG	ECG Comm. Stop	H	ECG module failure, or communication failure between the module and the host; please restart the device.
	ECG Comm. Error	H	
	ECG Config Error	H	
	ECG Self check Error	H	
	ECG Lead Off	M*	The electrodes are not connected to the patient firmly or fall off, or lead wires and the main cable fall off. Check the connection of electrodes and lead wires.
	ECG YY OFF (YY is a lead name)	M*	
Temp	TEMP1 Sensor Off	L	The temperature sensor falls off from the patient. Check the sensor connection.
	TEMP2 Sensor Off	L	
SpO2	SPO2 Comm. Stop	H	SpO2 module failure, or communication failure between the module and the host; please restart the device.
	SPO2 Comm. Error	H	
	SPO2 No Sensor	L	SpO2 sensor falls off from the patient or monitor, malfunctions, or sensor other than specified in this Manual is used. Check the sensor mounting position, whether the sensor is damaged or sensor type. Reconnect the sensor or use new sensor.
	SPO2 Sensor Off	L	
	SPO2 Sensor Error	L	
	SPO2 Search Timeout	L	
	SPO2 Search Pulse	L	Sensor signal is poor or too weak. Check the patient's condition, and place the sensor in a suitable position. If the failure persists, replace the sensor.
	SPO2 Signal Unstable	L	
	SPO2 Failure	L	
SPO2 Signal Weak	L		
NIBP	NIBP Comm. Stop	H	NIBP module failure, or communication failure between the module and the host; please restart the device.
	NIBP Comm. Error	L	
	NIBP Self check error	H	
	NIBP CFG Error	H	
	NIBP system error	H	If failure occurs during measurement, the system can't analyze and calculate. Check the patient's
	Measurement timeout	L	

Source	Alarm message	L	Causes and countermeasures
			condition, check the connections or replace the cuff, and then re-test.
	Cuff type error	L	The used cuff does not match the set patient category. Verify the patient category and replace the cuff.
NIBP	Cuff loose or no cuff	L	NIBP cuff isn't placed or connected properly, or there is gas leak.
	Cuff leak	L	Check cuff and inflation tube.
	Air pressure error	L	Ambient atmospheric pressure is abnormal. Confirm that the environment complies with the monitor's specifications, and check whether there are special reasons affecting ambient pressure.
	NIBP over range	L	The measured blood pressure of the patient exceeds the measuring range.
	NIBP signal weak	L	Patient's pulse may be weak or cuff is too loose. Check the condition of the patient, and place the cuff in a suitable position. If the failure persists, replace the cuff.
	NIBP signal unstable	L	Excessive movement may result in too much motion artifact or interference in the signal during measurement.
	NIBP signal saturated	L	Motion signal amplitude is too large due to movement and other reasons.
	NIBP over pressure	L	Cuff overpressure, and gas blockage may occur; check the gas path, and then re-measure.
	Module reset failed	L	NIBP module reset error; check the gas path is blocked, and then restart the measurement.
IBP	XX sensor off (XX represents an IBP label)	L	Check the sensor connection and reconnect the sensor.
CO2	CO2 communication stop	H	The CO2 module fails or module and host connection disconnected, reconnect the CO2 module to monitor.
	CO2 communication error	H	

	CO2 pipe off	L	Check CO2 pipe connection situation
	Check adapter	L	Check CO2 connected adapter or sampling pipes
	Check sampling pipe	L	
	Software error(CO2)	H	CO2 module fail, contact the maintenance staff.
	Sensor error(CO2)	L	Check CO2 sensor matched or not.
	CO2 exceed the measurement range.	L	The measured value exceed the measurement range claimed.
	CO2 sensor high temp	L	Check, remove heat source or waiting for the module to recover.
	CO2 Airway high press	L	An error occurred in the airway pressure. Check the patient connection and patient circuit, and then restart the monitor.
	CO2 check Cal	L	CO2 preform a calibration
	CO2 checking Cal failure	L	CO2 calibration module fails, please make sure the gas path etc, to recalibrate.
AG	AG module communication stop.	H	AG module fails or module and host connection disconnected, reconnect the module to monitor.
	AG module communication error	H	
	AG sensor off	L	Check AG module sensor connection situation.
	AG sensor error	L	Check AG module sensor match or not.
	AG software error	H	AG module fail contact the maintenance staff.
	AG hard ware error	H	
	AG precision range exceeded.	H	Measuring the range exceeded.
	AG temp range exceeded.	H	
	AG airway precision exceeded.	L	
	AG defaulted calibration is missing.	H	Re-calibrate the AG module.
	AG need zero calibrate	L	Perform a zero calibration.
	AG ID& Conc error	H	AG module ID error
	AG calibrating	L	AG module calibrating
	AG standby	L	AG module under standby

	AG measurement range calibrating	L	AG module calibrating.
	AG measurement range calibrated failed	H	Check AG airway and re-calibrate.
	Anesthetic Mixture	L	The system has detected more than one anesthesia gas. Check the ventilated anesthesia gas.
C.O.	TB sensor off	L	Check the sensor connection and reconnect the sensor.
	TI sensor off	L	Check the sensor connection and reconnect the sensor.
	C.O. measurement range exceed.	M	CO measurement value exceed the range, re-measure or check the patient conditions.
	C.O. communication error	H	C.O. module appear failed, connect the manufacturer
	C.O. communication error	H	C.O. module and host communication appear flailed, connect manufacturer
BIS	BIS communication stop	H	BIS module and host communication stop, check BIS module and host socket connected situation; plug-out BIS module and reconnect.
	BIS Confi error	H	BIS module can't working, check BIS module, replace the module if needed.
	BIS impedance too high	M	BIS sensor impedance check failed. Check placement of sensors and the connection, press the sensor in every electrode. Ensure the sensor connection of dry akin.
	BIS sensor off	M	BIS sensor connection off, check the sensor connection, reconnect the BIS sensor.
	BIS DSC error	H	BIS digital signal converter is not properly communication or work. Please contact maintenance staff.
	BIS DSC faulted	H	
	BIS disconnected cable	L	BIS cable not connected, check BIS cable connection, or reconnect.
	BIS disconnected sensor	L	Sensor not connected, BIS sensors need to Connected to reliable sensor before measurement.

BIS sensor using exceed limited	M	Sensor using the frequency or time too long, more than sensor using rules, Change the new sensor.
BIS SQI<50%	L	The BIS signal quality reliability is low, cannot be deduced, pseudo poor or too much interference EMG activity monitoring. 1. check the sensor; 2. Make sure that the BIS module is not close to other electrical radiation equipment.
BIS SQI<15%	L	
BIS sensor error	M	Not support the current BIS sensor, replace for new sensor.
BIS need to reconnect	M	BIS connection failure, reconnect the BIS module
BIS sensor invalid	M	BIS sensor failure, too old for use time more than the efficient time. The new sensor need to be replaced.
BIS connected simulator.	L	BIS connected demo simulator, At this moment is to demonstrate, not measuring patient.

# Appendix D Default Parameter Configuration

This chapter lists the important factory default settings of different departments in monitor configuration mode. Users can not change the default configuration, but can modify the settings as required and save as user-defined configuration.

Module	Option		Module defaults		
			Adult	Pediatric	
ECG	Alarm level		Mid	Mid	
	Alarm record		Off	Off	
	Lead type		5-lead	5-lead	
	Calculation channel		Auto	Auto	
	Power frequency suppression		On	On	
	Alarm limits		50~120 on	75~160 on	
	ST segment analysis	ST segment analysis		Off	Off
		Alarm level		Mid	Mid
		Alarm record		Off	Off
		Alarm limits		-0.2~0.2 on	-0.2~0.2 on
	Arrhythmia analysis	Alarm level		Mid	Mid
		Alarm record		Off	Off
		Alarm limits		0~10 on	0~10 on
		ARR alarm settings	Alarm switch	On	On
			Alarm level	Mid	Mid
			Alarm record	Off	Off
	Gain		x1	x1	
	Wave velocity		25.0mm/s	25.0mm/s	
Filter mode		Monitor	Monitor		
Wave color		Green	Green		
Wave style		Color scale	Color scale		
NIBP	Alarm level		Mid	Mid	
	Alarm record		Off	Off	
	Pressure unit		mmHg	mmHg	
	Measurement mode		Adult	Child	
	Interval		Manual	Manual	
	Display color		White	White	
	Pre-inflation value		150	100	
	Systolic blood pressure limit		90~160 on	70~120 on	

	Mean blood pressure limit	60~110 on	50~90 on
	Diastolic blood pressure limit	50~90 on	40~70 on
<b>SPO2</b>	Alarm level	Mid	Mid
	Alarm record	Off	Off
	Alarm limits	90~100 on	90~100 on
	Wave velocity	25.0	25.0
	Wave color	Cyan	Cyan
	Wave style	Line	Line
<b>RESP</b>	Alarm level	Mid	Mid
	Alarm record	Off	Off
	Apnea alarm	20 sec	20 sec
	Alarm limits	8~30 on	8~30 on
	Gain	x1	x1
	Wave velocity	12.5	12.5
	Wave color	Yellow	Yellow
	Wave style	Line	Line
<b>PR</b>	Alarm source	SPO2	SPO2
	Alarm level	Mid	Mid
	Alarm record	Off	Off
	Alarm limits	50~120 on	75~160 on
<b>TEMP</b>	Alarm level	Mid	Mid
	Alarm record	Off	Off
	Display color	White	White
	Temperature unit	°C	°C
	T1 alarm limits	36.0~39.0 on	36.0~39.0 on
	T2 alarm limits	36.0~39.0 on	36.0~39.0 on
	TD alarm limits	0.0~2.0 on	0.0~2.0 on







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