NONIN

Operator's Manual

Model 9847V

Veterinary Handheld Pulse Oximeter and Carbon Dioxide (CO$_2$) Detector

CE

English

> **CAUTION: Federal law (USA) restricts this device to sale by or on the order of a licensed practitioner.**

> **Consult Instructions for Use.**

Nonin® reserves the right to make changes and improvements to this manual and the products it describes at any time, without notice or obligation.

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Indications for Use

The Nonin Model 9847V Veterinary Pulse Oximeter and Carbon Dioxide Detector is indicated for use in measuring and displaying functional oxygen saturation of arterial hemoglobin (SpO_2), pulse rate, and approximate carbon dioxide (CO_2) changes in the airway of intubated animals. These functions may be used separately or simultaneously.

Pulse Oximeter Intended Use

The pulse oximeter is intended to be used for noninvasively monitoring oxygen saturation and pulse rate. The pulse oximeter may be used for spot checking and/or continuous monitoring when attended by a veterinary professional.

Carbon Dioxide Detector Intended Use

The CO_2 detector is a mainstream device intended to be used for semi-quantitative detection of CO_2 levels in intubated animals. The CO_2 detector may be used to initially confirm proper placement of the endotracheal tube and to provide continued confirmation of correct endotracheal tube placement and animal respiration status.

Contraindication

Do not use this device in an MR environment.

Warnings

The Model 9847V is intended for VETERINARY USE ONLY.
This device is not defibrillation proof per IEC 60601-1.
Explosion Hazard: Do not use in an explosive atmosphere or in the presence of flammable anesthetics or gasses.
This device is intended only as an adjunct in animal assessment. It must be used in conjunction with other methods of assessing clinical signs and symptoms.
Do not use the Model 9847V CO_2 detector during mouth-to-tube ventilation. The presence of CO_2 in the exhaled breath from the person performing resuscitation will cause inaccurate readings.
The Model 9847V detects exhaled CO_2. Standard clinical assessment must be used.
Oximeter readings of this device may be affected by the use of an electrosurgical unit (ESU).
Do not use a damaged sensor. If the sensor is damaged in any way, discontinue use immediately and replace the sensor.
Verify all alarm settings and limits during system startup to ensure that they are set as intended.
A hazard can exist if different presets are used on multiple 9847V monitors in one care area.
This device should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the device should be observed carefully to verify normal operation.

Warnings (Continued)

The use of accessories, sensors, and cables other than those specified may result in increased emission and/or decreased immunity of this device.
To avoid injury to the animal, use only with Nonin-branded PureLight® pulse oximeter sensors. These sensors are manufactured to meet the accuracy specifications for Nonin Pulse Oximeters. Using other manufacturers' sensors can result in improper pulse oximeter performance.
To prevent improper performance and/or injury to the animal, verify compatibility of the monitor, sensor(s), and accessories before use.
No modifications to this device are allowed as it may affect device performance.
Inspect the sensor application site at least every 6 to 8 hours to ensure correct sensor alignment and skin integrity. Each animal's sensitivity to Nonin sensors may vary depending on its medical status or the condition of its tissue.
Inadequate perfusion, thick fur, foreign matter that blocks light, or an improperly applied sensor can result in erratic and inaccurate oxygen saturation and/or pulse rate measurement. If proper operation cannot be verified, remove the sensor from the animal and DO NOT use the pulse oximeter.
The veterinary professional must investigate animal status and pulse oximeter sensor attachment after every pulse oximeter sensor alarm indication. It is possible for the pulse oximeter to display normal physiological values when the pulse oximeter sensor is dislodged from the animal. (This may happen under certain conditions of light and vibration of the sensor.)
As with all medical equipment, carefully route cabling to reduce the possibility of animal entanglement, strangulation, or injury.
Avoid excessive pressure to the sensor application site as this may cause damage to the skin beneath the sensor.
Do not reuse the Model 9840AAT Airway Adapter Tube. Cleaning the interior will damage the anti-fog coating and cause inaccurate readings or a CO_2 sensor alarm.
If the airway adapter tube packaging appears to be damaged or open, discard it and replace it with a new one.
The Model 9840AAT Airway Adapter Tube will increase dead space by approximately 6 cubic centimeters (0.4 cubic inches); this may adversely affect ventilation for animals with small tidal volumes.
If the Model 9847V CO_2 detector results are inconclusive, the correct anatomic location of the endotracheal tube must be confirmed by other methods.
Do not use the Model 9847V CO_2 detector with a humidifier or nebulizer in the breathing circuit, as the fine mist may cause erroneous readings.
Operation of this device below the minimum amplitude of 0.3% modulation may cause inaccurate results.
Before changing the batteries, make sure the device is off and the sensor is not applied to the animal.

Cautions

Before use, carefully read the Instructions for Use provided with sensors and airway adapters.
This device is a precision electronic instrument and must be repaired by trained Nonin personnel only.
Any sign or evidence of opening the system, field service by non-Nonin personnel, tampering, or any kind of misuse or abuse of the system, shall void the warranty in its entirety.

Cautions (Continued)

When mounting the monitor to a mobile pole, mounting the monitor higher than 1.5 meters (5 feet) or mounting more than 2 kilograms (4.5 pounds) of equipment onto the pole may result in tipping, damage to the equipment, or injury.
This device is not an apnea monitor.
Verify all visible indicators illuminate during the startup (initialization) sequence. If any indicator is not lit, do not use the device. Consult the troubleshooting guide or contact Nonin Technical Service for assistance.
Review all limits to ensure they are appropriate for the animal.
Setting alarm limits to extremes can render the alarm system useless.
This device may not work on all animals. If you are unable to achieve stable readings, discontinue use.
This device has motion tolerant software that minimizes the likelihood of motion artifact being misinterpreted as good pulse quality. However in some circumstances, the device may still interpret motion as good pulse quality.
This device must be able to measure the pulse properly to obtain an accurate SpO_2 measurement. Verify that nothing is hindering the pulse measurement before relying on the SpO_2 measurement. If the pulse quality or pulse rate displays are erratic or inaccurate, first examine the animal for any signs of distress and then reexamine sensor placement.
Do not autoclave or immerse the device or sensors in liquid. Do not expose the device or components to excessive moisture or liquids.
Do not use caustic or abrasive cleaning agents on the device or the sensors.
The oximeter sensor might not work on cold extremities due to reduced circulation. Warm or rub the sensor site to increase circulation, or reposition the sensor.
The device is not designed to retain data in memory once the batteries are removed. Memory will clear 60 seconds after removing the batteries. Replacing the batteries before 60 seconds have elapsed most likely will result in corrupt data.
Always replace the batteries with fully charged batteries. Do not use fully charged and partially charged batteries at the same time as this may cause the batteries to leak.
Use only Nonin-specified battery types with this device.
Do not use different types of batteries at the same time. Do not mix fully charged and partially charged batteries at the same time. These actions may cause the batteries to leak.
This device is a precision electronic instrument and must be repaired by qualified technical professionals. Field repair of the device is not possible. Do not attempt to open the case or repair the electronics. Opening the case may damage the device and void the warranty.
Batteries may leak or explode if used or disposed of improperly.
Remove the batteries if the device will be stored for more than 1 month.
Follow local, state and national governing ordinances and recycling instructions regarding disposal or recycling of the device and device components, including batteries.
In compliance with the European Directive on Waste Electrical and Electronic Equipment (WEEE) 2002/96/EC, do not dispose of this product as unsorted municipal waste. This device contains WEEE materials; please contact your distributor regarding take-back or recycling of the device. If you are unsure how to reach your distributor, please call Nonin for your distributor's contact information.
All parts and accessories connected to the serial port of this device must be certified according to at least IEC 60950 or UL1950 for data-processing equipment.

Cautions (Continued)

This equipment complies with IEC 60601-1-2 for electromagnetic compatibility for medical electrical equipment and/or systems. This standard is designed to provide reasonable protection against harmful interference in a typical medical installation. However, because of the proliferation of radio-frequency transmitting equipment and other sources of electrical noise in healthcare and other environments, it is possible that high levels of such interference due to close proximity or strength of a source might disrupt the performance of this device. Medical electrical equipment needs special precautions regarding EMC, and all equipment must be installed and put into service according to the EMC information specified.
Do not use the airway adapter tube if the airway adapter tube is below 5 °C (41 °F). An airway adapter tube that is below 5 °C (41 °F) may frost, causing a false reading. Warm the airway adapter tube to above 5 °C (41 °F) by putting it in a warm place (for example, in your hands or in a vehicle) prior to use.
An airway adapter that is between 5 °C (41 °F) and 10 °C (50 °F) may cause inaccurate reading due to fogging of optical surfaces. It is recommended that the airway adapter tube be warmed to above 10 °C (50 °F) before use.
Water or other liquid between the airway adapter tube and the CO_2 sensor may cause erroneous readings.
Ensure this device, the airway adapter tube, and the sensors have stabilized at the specified environmental operating conditions before use.
Portable and mobile RF communications equipment can affect medical electrical equipment.
Place a dark cloth or surgical drape over the pulse oximeter sensor in order to reduce interference from ambient light.
This device is designed to determine the percentage of arterial oxygen saturation of functional hemoglobin. Factors that may degrade pulse oximeter performance or affect the accuracy of the SpO_2 measurement include the following: - excessive ambient light   - inadequate signal - excessive motion   - venous pulsations - electrosurgical interference   - anemia or low hemoglobin concentrations - blood flow restrictors (arterial catheters, blood   - cardiogreen and other intravascular dyes   pressure cuffs, infusion lines, etc.)   - carboxyhemoglobin - improperly applied sensor   - methemoglobin - incorrect sensor type   - dysfunctional hemoglobin
Certain pharmacologic agents used to sedate or anesthetize animals may have cardiovascular effects that can adversely affect the performance of the pulse oximeter by reducing the perfusion to the sensor site. Examples of commonly used agents that may have this type of effect on certain animal species are Detomidine HCl and Xylazine HCl.
There is a wide range of variability between animal species and their respective differences in anatomy, physiology, and responses to veterinary pharmacological agents. Therefore, the veterinary professional will need to use discretion when selecting sensors and/or sensor sites that are appropriate for the animal species and the monitoring conditions.
When attaching the pulse oximeter sensor, make sure to secure the sensor in a manner that will not restrict perfusion. An improperly applied sensor could inhibit proper function of the pulse oximeter and cause discomfort or localized ischemia to the animal.
A functional tester cannot be used to assess the accuracy of a pulse oximeter monitor or sensor.
Ensure all connections to the airway adapter tube are tight and leak-free, and that the airway adapter tube is properly attached to the CO_2 sensor.
CO_2 detector readings may be elevated by approximately 6% when used in the presence of 50% nitrous oxide gas (N_2O). Lower concentrations of N_2O have a smaller effect.

Cautions (Continued)

Gastric distention with air prior to intubation may introduce CO_2 into stomach and esophagus and yield false results. Observe six breaths before interpreting results.
Do not block the audible indicator speaker holes. Blocking the speakers will significantly reduce the sound volume.
Verify the audible alarms can be heard over the ambient noise of the operating environment.
Radios and cell phones or similar devices can affect the equipment and must be kept at least 2 meters (6.5 feet) away from equipment.
Failure of a network data coupling (serial cable/connectors/wireless connections) will result in loss of data transfer.

Guide to Symbols

This table describes the symbols found on the Model 9847V and in this manual.

Table 1: Symbols

Symbol	Description
⚠	CAUTION!
📖	Consult Instructions for Use.
👆📖	Follow Instructions for Use.
🧍	Type BF Applied Part (Patient isolation from electrical shock).
c(UL)us CLASSIFIED	UL Mark for Canada and the United States with respect to electric shock, fire, and mechanical hazards only in accordance with UL 60601-1 and CAN/CSA C22.2 No. 601.1.
SN	Serial Number (located on the back cover).
IP32	Protected against vertically falling water drops when enclosure is tilted up to 15 degrees and ingress of solid foreign objects greater than or equal to 2.5 mm (0.1 in.) in diameter per IEC 60529.
🗑	Indicates separate collection for electrical and electronic equipment (WEEE).
CE	CE Marking indicating conformance to EC Directive No. 93/42/EEC concerning medical devices.
🏭	Manufacturer
Front Panel Buttons	
⏻	On/Standby
◁◻◻	Advance/Breath Beep Volume Control
↕	Alarm Limit Review
🔕	Audible Alarm Disabled
Display Indicators	
%SpO$_2$	SpO$_2$ Display
🔋	Low Battery Indicator
((♥))	Pulse Rate Display
⋀	Pulse Quality Indicator
Δ **CO$_2$**	Change in CO$_2$ Concentration
No Breath	Absence of CO$_2$ Detection

Introduction

General Description

Nonin 9847V Veterinary Pulse Oximeter and Carbon Dioxide Detector is a hand-held, battery-operated, noninvasive monitoring device that has visible and/or audible indicators for tracking animal and equipment status. The 9847V will typically operate for 90 hours continuously between battery replacements when used for pulse oximetry alone, or for 20 hours continuously when used for both CO_2 detection and pulse oximetry.

Figure 1: Model 9847V Veterinary Pulse Oximeter and Carbon Dioxide Detector with Alarms

Figure 2: Model 9847V Controls and Indicators

Audible Alarms and Informational Tones

9847V uses audible alarms and informational tones (along with visible indicators) to alert veterinary professionals to several animal and equipment conditions. A high priority (animal) alarm alerts the veterinary professional of a animal's absence of breath, high or low oxygen saturation, pulse rate, or inadequate pulse quality signal. A medium priority (equipment) alarm indicates the batteries have reached critically low capacity, or that a sensor alarm condition is occurring. An informational tone (a beep) indicates a non-alarm event (a breath).

The audible alarms can be permanently or temporarily disabled using the Audible Alarm Disable button.

About Pulse Oximetry

9847V determines functional oxygen saturation of arterial hemoglobin (SpO$_2$) by measuring the absorption of red and infrared light passed through perfused tissue. Changes in absorption caused by pulsation of blood in the vascular bed are used to determine arterial saturation and pulse rate.

Oxygen saturation and pulse rate values are indicated on light-emitting diode (LED) digital displays. On each detected pulse, the Pulse Quality indicator blinks. Animal pulse quality signals are graded as good, marginal, or inadequate and are indicated as such by the Pulse Quality indicator blinking green, yellow, or red respectively. This simple method gives the user a pulse-by-pulse visual indication of waveform signal quality without requiring the user to perform complex waveform analysis during critical animal care situations.

If an inadequate pulse is detected, the Pulse Quality indicator blinks red and a high priority animal audible alarm sounds.

If the SpO$_2$ or the pulse rate meets or exceeds user-defined alarm limits, the corresponding numerical value blinks on the SpO$_2$ or pulse rate displays and a high priority animal audible alarm sounds.

If the pulse oximeter sensor is disconnected, malfunctions, or an adequate signal is not detected:

1. A dash appears in the leftmost position of the SpO$_2$ display.
2. The displayed SpO$_2$ and pulse rate values freeze for 10 seconds.
3. A medium priority equipment alarm sounds (unless the audible alarms are disabled or unless overridden by a high priority animal alarm).
4. 10 seconds after the first dash appears, dashes replace the SpO$_2$ and pulse rate values if the condition is not corrected.
5. The dashes blink if an animal alarm was in process.

Carbon Dioxide Detector

9847V determines approximate CO_2 changes in the airway of intubated animals by measuring the absorption of mid-infrared light passed through the airway adapter tube. The approximate CO_2 concentration change is indicated by an eight-segment LED bar graph display. The CO_2 detector relies on the assumption that the inhaled air contains minimal amounts of CO_2.

Breaths are indicated when the CO_2 level increases by approximately 5 mmHg during exhalation. A detected breath is indicated on the CO_2 bar graph and by an audible breath beep.

When no breath is detected:

1. A high priority animal audible alarm sounds.
2. The No Breath indicator blinks.
3. The lowest CO_2 bar graph segment is lit, and CO_2 readings are displayed with the next breath detected.

Medium priority (equipment) alarms occur when:

• The CO_2 sensor is unplugged.
• The airway adapter tube is removed from the CO_2 sensor.
• The light path is blocked.
• A CO_2 sensor failure occurs.

A high priority (animal) alarm overrides a medium priority alarm. If the audible alarms are disabled, the third and sixth bars are solidly lit.

Unpacking the Model 9847V

Contact the carrier immediately if the shipping carton is damaged. Carefully unpack the device and its accessories. Nonin's standard package configuration consists of the following items:

• 1 Model 9847V Veterinary Pulse Oximeter and CO_2 Detector
• 1 Operator's Manual (on CD)
• 1 Model 2000SL Lingual Clip Sensor
• 1 Model 9840SA Carbon Dioxide Sensor
• 3 Model 9840AAT Airway Adapter Tubes
• 1 Model UNI-EXT-3 Extension Cable (for pulse oximeter), 3 meters (10 feet)
• 1 Model 8500TS Tabletop Stand
• 6 AA-Size Alkaline Batteries

If any item on this list is missing or damaged, contact your distributor.

![Nonin logo]

Batteries

9847V is powered by six AA size alkaline batteries. Approximate battery capacity:

- Pulse oximeter (SpO$_2$) only: 90 hours
- CO$_2$ and pulse oximeter: 20 hours
- CO$_2$ only: 24 hours

The Low Battery indicator ▭ is lit when the battery capacity is low. Replace the batteries as soon as possible.

Critical battery capacity is indicated by:

- Low Battery indicator blinks
- Medium priority (equipment) alarm

To avoid loss of monitoring, batteries must be replaced immediately.

NOTE: Audible high priority animal alarms override medium priority alarms.

If the batteries are critically low when the device is turned on, setup mode is disabled and the displays are blank. Replace the batteries before continuing.

⚠ **CAUTION:** Use only Nonin-specified battery types with this device.

NOTE: To conserve battery life, disconnect the CO$_2$ sensor when not in use.

NOTE: Setting the month to "☐☐" disables the calender and clock functions and helps conserve battery life. Refer to "Calendar Settings" on page 23 for additional information.

Replacing Batteries

WARNING: Before changing the batteries, make sure the device is off and the sensor is not applied to the animal.

1. Slide open and remove the battery door on the bottom of the device.
2. Remove **all six** batteries.
3. Replace all six batteries with new AA size batteries (figure 3) with the proper battery orientation noted on the back of the device (figure 4).

⚠ **CAUTION:** The device is not designed to retain data in memory once the batteries are removed. Memory will clear 60 seconds after removing the batteries. Replacing the batteries before 60 seconds have elapsed most likely will result in corrupt data. Always replace the batteries with fully charged batteries. Do not use fully charged and partially charged batteries at the same time as this may cause batteries to leak.

IMPORTANT: Insert these two batteries first.

Battery Orientation

Battery Door

Figure 3: Replacing Batteries - Model 9847V

VETERINARY USE ONLY

CLASSIFIED

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UL 60601-1
30EM

SN

NONIN MEDICAL, INC.
PLYMOUTH, MN USA
MODEL 9847V
VETERINARY
PULSE OXIMETER/CO2 DETECTOR
SEE ACCOMPANYING DOCUMENTS

IP32

$C\epsilon$

6x1.5V AA IEC LR6
US PATENT # Re. 33,643
5808-006-04

Serial Number

Battery Orientation

Battery Door

Figure 4: Rear View - Model 9847V

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When batteries are critically low, the digital displays go blank, and the Pulse Quality indicator blinks yellow or red, but not green.

> ⚠ **CAUTION:** Replace the batteries as soon as possible after a low battery indication. Always replace the batteries with fully charged batteries. Do not use fully charged and partially charged batteries at the same time. This may cause the batteries to leak.

> ⚠ **CAUTION:** Remove the batteries if the device will be stored for more than 1 month.

Important Notes about Battery Use

- To conserve battery life, Nonin recommends disconnecting the CO_2 sensor from the 9847V when CO_2 detection is not in use. The flashing lamp in the CO_2 sensor consumes a significant amount of energy.

- Six alkaline batteries provide the following number of hours of continuous operation:
  - Pulse oximeter only - 90 hours
  - CO_2 sensor only - 24 hours
  - Pulse oximeter and CO_2 sensor - 20 hours

- The memory of the 9847V may be erased when the batteries are removed.

- Replacing batteries may erase the clock settings of the 9847V.

- Calendar/clock settings can affect battery storage life. Batteries drain during storage, but they drain more quickly when the unit's calendar/clock functions are set. Setting the month to "☐☐" disables the calendar and clock functions and helps conserve battery life. Refer to "Calendar Settings" and "Clock Settings" (page 23) for more information.
  - If the calendar/clock is not set when the unit is stored, alkaline batteries will need replacement in 10-12 months if the unit has not been used.
  - If the calendar/clock is set when the unit is stored and if the unit has not been used, alkaline batteries will require replacement in about 6 weeks.

Setting Up the Tabletop Stand

The Model 8500TS Tabletop Stand can be used to place the Model 9847V in a viewable position. Slide the Model 9847V into the stand, then swing the metal leg into position behind the stand to form a solid base. Route the Model UNI-EXT-3 Extension Cable or the pulse oximeter sensor cable through the notch at the bottom edge of the stand (figure 5).

Route the cable through the notch

Figure 5: Setting Up the Model 8500TS Tabletop Stand

Additional hardware is available for mounting the Model 8500TS on the wall or in a pole mount configuration. See "Accessories" on page 43 for more information.

Displays and Indicators

The following is an overview of the device's displays and indicators (figure 2). See "Visible Indicators" on page 23 for more detailed information.

SpO$_2$ Display

Identified by the **%SpO$_2$** symbol, this 3-digit light-emitting diode (LED) display shows the current oxygen saturation percentage.

This display also indicates if a pulse oximeter sensor fault or inadequate signal condition exists. If one exists, a dash (-) appears in the leftmost position of the SpO$_2$ display and the readings freeze. After 10 seconds, a dash appears in the middle position of the SpO$_2$ display.

Pulse Rate Display

Identified by the ((❤)) symbol, this 3-digit LED display shows the pulse rate in pulses per minute.

During a pulse oximeter sensor fault or inadequate signal condition, the pulse rate display freezes for 10 seconds and then a dash appears in the middle position of the display.

CO$_2$ Bar Graph Display

Identified by the $\triangle$**CO$_2$** symbol, this eight-section bar graph displays the change in CO$_2$ level as the animal inhales and exhales through the airway adapter tube.

Pulse Quality Indicator

Identified by the $\wedge$ symbol, this tri-color LED blinks once for each detected pulse. The LED color changes with the pulse strength signal:

- **Green** indicates a good pulse strength signal.
- **Yellow** indicates a marginal pulse strength signal. To improve signal quality, reposition the sensor, try a different sensor type, reduce animal movement, or improve the site's circulation.
- **Red** indicates an inadequate pulse strength signal. While the Pulse Quality display is red, SpO$_2$ and pulse rate values are not updated. After about 10 seconds, the values are replaced with dashes, indicating that readings are not possible.

Low Battery Indicator

Identified by the ▭ symbol, this LED indicator is lit when battery level is low. When the batteries reach critically low level, the display is blank and the Low Battery indicator blinks.

No Breath Indicator

Identified by the **No Breath** symbol, this LED indicator is a high priority animal alarm. It flashes when breath is not detected for a period of time that exceeds the set no breath delay time.

Audible Alarm Disabled Indicator

Identified by the ⚠ symbol, this LED indicator is steadily lit when the audible alarm is permanently disabled and blinks when the audible alarm is temporarily disabled. It also provides the user with an "on" indication when sensors are not attached to the device.

Alarm Indicator

This LED indicator blinks when a sensor fault or inadequate signal condition exists or if a pulse oximeter signal is no longer detected.

Using the 9847V Pulse Oximeter

Connecting the Sensors

Pulse Oximeter Sensor

Attach the sensor (with the Nonin logo facing up) to the device (figure 6). Verify the sensor is securely connected.

Figure 6: Connecting Sensors to the Model 9847V

Carbon Dioxide Sensor and Airway Adapter Tube

Connect the CO_2 sensor (with the Nonin logo facing up) to the side of the device (figure 6). Verify the sensor is securely attached. Refer to "Carbon Dioxide Sensor" on page 33 for more information.

Turn On/Standby

Press **On/Standby** ⏻ to turn the device on or off.

Device Startup

When the device is turned on, the device cycles through a startup/initialization sequence before displaying valid data. During startup, always check for missing indicators or LED display segments. If any indicator is not functioning, do not use the device. Contact Nonin Technical Service for repair or replacement.

During its normal startup sequence, the device cycles as follows:

1. Audible breath beep sounds 3 times.
2. No Breath indicator displays for approximately 2 seconds.
3. Low Battery indicator displays for approximately 2 seconds, unless the batteries are low.
4. Pulse Quality indicator blinks red, then green. The device enters standby if no pulse oximeter sensor is connected.

No Breath

5. SpO$_2$ and pulse rate (❤) display the following sequence:

   a. `888 888`

   b. Current time (if set), or `00   00` (if time not set)

   c. Software revision numbers for oximeter/display, CO$_2$ memory, and sound module display for approximately 1 second each.

   d. Any sensor connections issues:

   • If a sensor is not connected, the display reverts to blank.

   • If a sensor is connected but is not detecting an adequate signal, a single dash (`-`) appears in the middle position of both displays.

   • If entering setup mode, the device displays `ALr` and `dFt`.

6. The CO$_2$ bar graph displays this sequence:

   a. Each segment illuminates once.

   b. Then it either remains blank (no CO$_2$ sensor connected to the device), or the bottom segment is lit (CO$_2$ sensor is connected to the device and it is ready for use).

7. The yellow Audible Alarm Disabled indicator is lit until initialization is complete and a CO$_2$ or pulse oximeter sensor is connected.

NOTE: The audible alarm disabled indication cannot be turned off until a sensor is plugged in.

NOTE: When 9847V is turned on and the alarms are disabled, the yellow Audible Alarm Disabled indicator remains lit.

Pulse Oximeter Startup

Apply the pulse oximeter sensor to the animal as directed in the sensor Instructions for Use. Verify operation:

1. Pulse Quality indicator ⋀ blinks green.

2. Pulse rate (❤) and SpO$_2$ (**%SpO$_2$**) displays show values.

3. Pulse Quality indicator blinking is correlated to the pulse rate for at least 10 seconds.

If the Pulse Quality indicator LED blinks red or yellow or blinks inconsistently, reposition the sensor or replace the sensor.

If a pulse oximeter sensor is not attached to the pulse oximeter after system initialization (a few seconds after powering on), both the SpO$_2$ and pulse rate displays remain blank and the Audible Alarm Disabled indicator blinks, indicating the Model 9847V is "on."

Event Marker

Press **Alarm Limit Review** to activate an event marker. Marked events will display as an asterisk (*) at the end of the real-time data output.

Carbon Dioxide Detector Startup

Verify:

1. Airway adapter tube is properly attached to the CO_2 sensor.
2. CO_2 sensor is properly connected to the device.
3. Lower bar of the CO_2 display is lit.
4. CO_2 sensor light is blinking.
5. CO_2 bar graph segments indicate change in CO_2 level.

Attach the CO_2 sensor/airway adapter tube to the animal's endotracheal tube. The CO_2 detector will reflect values and breath beeps for each breath (if the breath beep sound volume is not turned off).

A medium priority (equipment) alarm will occur (if the alarms are not disabled), when:

- The CO_2 sensor is disconnected.
- The airway adapter tube is removed from the CO_2 sensor.
- The light path is blocked.
- A CO_2 sensor failure occurs.

High priority (animal) alarms override medium priority (equipment) alarms. The third and sixth segments of the CO_2 bar graph will be lit, indicating a CO_2 sensor fault.

Setup

All functions of the 9847V are controlled by buttons found on the keypad on the front of the device.

Press **On/Standby** to turn the device on or to enter Standby mode.

Setup Mode

Setup mode is used to control the audible and visible animal alarm limits, the breath beep pitch, the calendar, and the internal clock.

In setup mode, the Alarm Limit Review button is used to make the menu selections, and the Advance button is used to change the value.

On / Standby

Advance / Breath Beep Volume Control

Alarm Limit Review

Audible Alarm Disabled Indicator (Yellow)

Audible Alarm Disable

Keypad

Low Battery (LED) Indicator (Yellow)

Entering Setup Mode

1. With the unit in Standby mode, press and hold **Alarm Limit Review** while pressing and then releasing **On/Standby**.

2. Release **Alarm Limit Review** when 8̄8̄8̄ 8̄8̄8̄ displays on the SpO$_2$ and pulse rate displays. Three brief beeps sounds, and ALr and dFt appear in the SpO$_2$ and pulse rate displays.

NOTE: Entering setup mode with audible alarms disabled:

1. Press and hold **Alarm Limit Review** and **Audible Alarm Disable** while pressing and releasing **On/Standby**.

2. Release **Alarm Limit Review** and **Audible Alarm Disable**. The display appears as described in #2 above, and the Audible Alarm Limit indicator is steadily lit.

NOTE: You may exit setup mode at any point and save your current animal alarm limit changes (without stepping through the remainder of the setup mode menu options).

1. Complete the desired selections, then turn off the 9847V.

2. Next, enter setup mode again and choose rCL (recall stored limits) from the alarm mode settings.

NOTE: Setting the month to "00" disables the calendar and clock functions and helps conserve battery life.

NOTE: Setup mode is disabled if the batteries are critically low at power on.

Making Selections in Setup Mode

1. Upon entering setup mode, "ALr" (the first parameter) appears in the SpO$_2$ display. Press **Advance** (or press and hold to quickly scroll) to increment the range of values on the pulse rate display. The menu starts at the current value stored in memory for the parameter designated in the SpO$_2$ display and cycles through the range of values listed in Table 2.

2. When the value appears in the pulse rate display, press **Alarm Limit Review** to store the value and advance the SpO$_2$ display to the next sequential parameter (no breath delay time, alarm limit, etc.) as listed in Table 2.

3. Continue this process until all parameters are set.

4. When the setting sequence has been completed, the 9847V:

    a. Exits setup mode.
    b. Briefly displays rCL ALr (recall alarm settings), followed by the alarm limit settings.
    c. Begins normal operation.

Table 2: Alarm Limit, Breath Beep Pitch, Calendar, and Clock Mode Parameter

Parameter	Appears in SpO$_2$ Display	Pulse Rate Display Range of Values	Default Value
Alarm Mode dFt =default limits rCL = recall stored limits CO2 = only no breath and the sensor alarms	ALr	dFt, rCL, CO2	dFt
No Breath Delay (seconds)	nbd	15 to 60 by 5, OFF	20
Oxygen Saturation Low Limit (%)	O2L	50 to 95 by 1, OFF	85
Pulse Rate Low Limit (beats/minute)	H L	20 to 200 by 5, OFF	50
Pulse Rate High Limit (beats/minute)	H H	100 to 425 by 25, OFF, 50 to 100 by 5	200
Oxygen Saturation High Limit (%)	O2H [a]	80 to 100 by 1, OFF	OFF
Breath Beep Pitch (fixed or variable)	FPt	ON or OFF	OFF (fixed pitch off)
Year	y	00 - 99	09
Month	nn	00 - 12	00
Day	d	01 - 31	00
Hours	h	00 - 23	00
Minutes	nn	00 - 59	00

a.The default setting for O2H is OFF (disabled). Any of the other animal alarm limit parameters can be individually disabled by setting to OFF.

Disabling the Audible Alarms

The audible alarms can be temporarily disabled, or they can be permanently disabled at power on when entering setup mode using the Audible Alarm Disable button.

When the audible alarms are disabled, informational beeps continue to sound at the set volume, and the visible alarm indicators remain enabled.

Temporarily Disabling the Audible Alarms (Maximum 2 Minutes)

1. With the unit on, press and then release **Audible Alarm Disable**.

2. The Audible Alarm Disabled indicator blinks.

3. The audible alarms will be disabled for 2 minutes (unless overridden by an audible critical battery alarm).

4. The audible alarms can be re-enabled by pressing **Audible Alarm Disable** again before the 2-minute period has expired.

Disabling the Audible Alarms During Power On

1. With the unit in Standby, press and hold **Audible Alarm Disable** while pressing and then releasing **On/Standby**.

2. Release **Audible Alarm Disable** when 𝟠𝟠𝟠 𝟠𝟠𝟠 displays on the SpO_2 and pulse rate displays.

3. After the power on self-test, the Audible Alarm Disabled indicator is steadily lit. The animal alarms are set at the default limits.

4. The audible alarms can be re-enabled by pressing **Audible Alarm Disable** again.

Setting Parameters

NOTE: The Advance button sets your selection. The Alarm Limits button moves you to the next setting.

NOTE: See page 20 for Table 2 - Alarm Limit, Breath Beep Pitch, Calendar, and Clock Mode Parameters.

Alarm Mode Setting

WARNING: Verify all alarm settings and limits during system startup to ensure that they are set as intended.

⚠ **CAUTION:** Review all limits to ensure they are appropriate for the patient.

⚠ **CAUTION:** Setting alarm limits to extremes can render the alarm system useless.

1. Upon entering setup mode, "ALr" appears in the SpO_2 display indicating alarm mode. The alarm mode may be set to dFt, rCL, or CO2:

    • dFt (default limits) sets up the system-defined (default) animal alarm limit settings.

    • rCL (recall stored limits) sets up the last stored animal alarm limit settings of the 9847V.

    • CO2 (no breath alarm limits and sensor alarms) temporarily disables the oxygen saturation high and low settings and the pulse rate high and low settings by setting them to OFF. Only the no breath alarm and the sensor alarms are enabled, along with the breath beep pitch mode selection. Setup mode skips over the other animal alarm settings (i.e., CO2 alarm mode first goes to nbd, then to FPt, etc.).

2. When the alarm mode setting has been selected, setup mode continues to the no breath delay time setting.

No Breath Delay Time Setting

1. Upon entering no breath delay time setup, "nbd" appears in the SpO_2 display. The no breath delay time may be set from 15 to 60 (seconds) in increments of 5, or to OFF.

2. When the no breath delay time has been selected, setup mode continues to the SpO_2 low alarm limit setting (CO2 alarm mode goes to FPt next, then to y, etc.).

SpO₂ Low Alarm Limit Setting

1. Upon entering the SpO_2 low alarm limit, "O2L" appears in the SpO_2 display. The SpO_2 low alarm limit may be set from 50 to 95 (%) in increments of 1, or to OFF.

2. When the SpO_2 low alarm limit setting has been selected, setup mode continues to the pulse rate alarm limit settings.

Pulse Rate Alarm Limit Setting

1. Upon entering the pulse rate low alarm limit, "H L" appears in the SpO_2 display. The pulse rate low alarm limit may be set from 20 to 200 (beats per minute) in increments of 5, or to OFF.

2. After selecting the pulse rate low alarm limit, the SpO_2 display shows "H H" indicating the setup mode for the pulse rate high alarm limit. The pulse rate high alarm limit may be set to one of the following:

    *   100 to 425 (beats per minute) in increments of 25
    *   OFF
    *   50 to 100 (beats per minute) in increments of 5

3. When the desired pulse rate high alarm limit setting has been selected, setup mode continues to the SpO_2 high alarm limit settings.

SpO₂ High Alarm Limit Setting

1. Upon entering the SpO_2 high alarm limit, "O2H" appears in the SpO_2 display. The SpO_2 high alarm limit may be set from 80 to 100 (%) in increments of 1, or to OFF.

2. When the SpO_2 high alarm limit setting has been selected, setup mode continues to the breath beep pitch settings.

Breath Beep Pitch Setting

1. Upon entering the breath beep pitch, "FPt" appears in the SpO_2 display. The breath beep pitch defaults to variable pitch (fixed pitch off). Refer to "Breath Beep" on page 28 for additional information.

2. The breath beep pitch selection may be toggled between ON or OFF.

Calendar and Clock Settings

Calendar Settings

NOTE: Setting the month to "⸣⸣" disables the calendar and clock functions. The calendar and clock functions are used to time stamp real-time data for memory. Unless you intend to use real-time data output or memory playback options, skip this section.

1. After the calendar setting has been selected in the setup mode, "y" appears in the SpO$_2$ display indicating the calendar setup mode for the year. The year may be set to ⸣⸣ through ⁹⁹.

2. After selecting the year, the display shows "nn," indicating the setup mode for the month. The month may be set to ⸣⸣ through 12.

3. After selecting the month, the display will show "d," indicating the setup mode for the day of the month. The day may be set to ⸣1 through 31.

4. After selecting the day, the setup mode continues to the clock settings.

Clock Settings

1. After the calendar settings have been selected in the setup mode, "h" appears in the SpO$_2$ display indicating clock setup mode for the hour. The hour may be set to ⸣⸣ through 23.

2. After selecting the hour, the SpO$_2$ display shows "nn," indicating the setup mode for minutes. The minutes may be set to ⸣⸣ through 59.

3. After selecting the minutes, the device will:

    a. Exit setup mode.

    b. Briefly display rCL ALr (recall alarm settings) and then the current alarm limit settings.

    c. Begin normal operation.

Visible Indicators

Refer to Figure 2 on page 7 for a detailed illustration of the 9847V controls and indicators.

The intended operator's position for correctly perceiving a visual alarm signal and its priority is 1 meter (3.3 feet), per IEC 60601-1-8.

SpO$_2$ Display

The SpO$_2$ display is the upper numeric display. This 3-digit light-emitting diode (LED) display shows the current oxygen saturation percentage.

Pulse Rate Display

The pulse rate display is the lower numeric display. This 3-digit LED display shows pulse rate in pulses per minute.

SpO$_2$ and Pulse Rate Displays

A pulse oximeter sensor fault occurs if the 9847V pulse oximeter detects a sensor disconnect, dislodgement, or failure.

If a pulse oximeter sensor fault occurs or a sensor signal is no longer detected, a medium priority (equipment) alarm starts. A dash (-) appears in the left digit of the SpO$_2$ display, and the displayed readings freeze for 10 seconds if the sensor fault or inadequate signal continues. During this medium priority alarm, an audible indicator occurs.

If the sensor fault or inadequate signal is not corrected, dashes display in the middle digit of both the SpO$_2$ and pulse rate displays 10 seconds after the first dash appeared. The corresponding dash(es) blink if there was a prior high priority animal alarm. When the sensor fault or inadequate signal is corrected, the SpO$_2$ and pulse rate displays return to normal operation.

When the SpO$_2$ or pulse rate alarm limits are met or exceeded, a high priority animal alarm condition exists. The numerical values of the corresponding parameter blink and an audible alarm occurs. If either the SpO$_2$ or pulse rate visible high priority animal alarms are latched (continue) and the oximeter enters the critical battery state, the parameter will show 3 blinking dashes in the corresponding displays.

If latched for a pulse oximeter medium priority equipment alarm (a sensor fault or inadequate signal), a single blinking dash displays in the corresponding middle digit of the SpO$_2$ or the pulse rate display.

The visible and audible indicators stop when the condition is cleared.

Alarm Limit Review

When the Alarm Limit Review button is pressed and held, the animal alarm limits in effect for no breath delay time (in seconds), SpO$_2$, and pulse rate, as well as the breath beep pitch setting, display in sequence for approximately 2 seconds in the order and format shown in Table 3. If the button is released, the review mode is exited and normal operation resumes.

Table 3: Alarm Limits Displayed During an Alarm Limit Review

Parameter	Appears in SpO$_2$ Display	Alarm Limits (Default Values Shown)
No Breath Delay (seconds)	nbd	20
Oxygen Saturation Low Limit (%)	O2L	85
Pulse Rate Low Limit (beats/minute)	H L	50
Pulse Rate High Limit (beats/minute)	H H	200
Oxygen Saturation High Limit (%)	O2H	OFF
Breath Beep Pitch (fixed or variable)	FPt	OFF (fixed pitch off)

During the alarm limit review only the SpO_2 and pulse rate displays are affected. The current SpO_2 and pulse rate measurements display after completing the limit review. If a critical battery state exists, the alarm limit review sequence does not appear.

NOTE: Pressing and holding the Alarm Limit Review button can be used to review alarm limits <u>and</u> to activate an event marker.

Pulse Quality Indicator

⚠️ **CAUTION:** The device has motion tolerant software that minimizes the likelihood of motion artifact being misinterpreted as good pulse quality. However in some circumstances, the device may still interpret motion as good pulse quality.

The Pulse Quality indicator ⌁ blinks once for each pulse while measuring oxygen saturation. The Pulse Quality indicator changes color to indicate changes in the pulse waveform signal that may affect the SpO_2 data.

The Pulse Quality indicator blinks one of three colors:

• **Green** indicates the pulse waveform signal is of good quality and the SpO_2 and pulse rate data are accurate.

• **Yellow** indicates the pulse waveform amplitude is marginal or that the pulse oximeter has detected artifact. Although the SpO_2 and pulse rate data may be acceptable, corrective measures should be considered if the indicator continues to blink yellow frequently. To improve signal quality, try repositioning the sensor, using a different sensor type, eliminating animal movement, or improving circulation at the site by massaging the area.

• **Red** indicates the pulse waveform amplitude is inadequate. During red pulse quality, SpO_2 and pulse rate values are not updated. A high priority animal alarm occurs. After approximately 20 seconds, the values are replaced with dashes indicating that SpO_2 and pulse rate measurements are not possible. (Also during this high priority animal alarm, the high priority audible pulse quality alarm sounds if the audible alarms are not disabled.)

No Breath Indicator

The No Breath indicator, a high priority animal alarm, flashes when a breath has not been detected for a period of time that exceeds the set no breath delay time (measured in seconds). During this alarm, the high priority audible no breath alarm sounds if the audible alarms are not disabled. (See "No Breath Alarm" on page 29 for additional information.)

If a CO_2 sensor alarm occurs, existing visible and audible absence of breath indicators latch. However in most cases, during "fixed pitch" breath beep mode, when the airway adapter tube is unsnapped from the CO_2 sensor, the visible and audible absence of breath indicators stop.

When a breath is again detected, the visible and audible no breath indicators stop. The no breath delay timer is first started when the CO_2 sensor is plugged into the 9847V and the system is not in setup mode (when the lower bar is lit on the CO_2 display).

CO$_2$ Bar Graph

The CO$_2$ bar graph ΔCO$_2$ remains blank until the CO$_2$ sensor is plugged in. When an airway adapter tube is connected to the CO$_2$ sensor and an adequate signal is detected, the bottom bar is initially lit. The bars are lit to indicate the change in CO$_2$ level as the animal exhales and inhales through the airway adapter tube.

The 3rd and 6th bars of the CO$_2$ bar graph are lit if a medium priority (equipment) alarm is started. (See page 30 for additional alarm information.)

CO$_2$ values are displayed as a range between two threshold values. The threshold values are located between each CO$_2$ bar. The values (displayed in both mmHg and kPa) are an approximate measurement of the change in CO$_2$ level in the airway adapter tube. For example, if four bars are lit, the detected CO$_2$ level change lies within the range $\geq$10 mmHg and <20 mmHg (the threshold values).

NOTE: Because the CO$_2$ detector is a semi-quantitative device, the rising and falling CO$_2$ bar graph should NOT be interpreted as a CO$_2$ waveform.

Low Battery Indicator

The Low Battery indicator ⬒ is steadily lit when the battery level is marginal. The batteries should be replaced as soon as possible.

When the battery level is low:

1. The Low Battery indicator blinks.
2. A medium priority (equipment) audible alarm starts (unless a high priority (animal) audible alarm is in progress).
3. If the respective alarms are not "latched" (will not continue):
   a. SpO$_2$, pulse rate, and CO$_2$ bar graph indicators are blank
   b. Pulse Quality indicator blinks yellow or red, but not green.
4. If an existing visible high priority (animal) alarm is "latched" (continues):
   a. A latched no breath alarm causes the No Breath indicator to blink.
   b. A latched high or low SpO$_2$ or pulse rate alarm displays 3 dashes blinking in the corresponding numeric display.
   c. A latched pulse quality alarm blinks red.

When the batteries are critically low:

1. Low Battery indicator blinks.
2. Setup mode is disabled.
3. Displays are blank (no animal data).
4. Batteries must be replaced.

The device will not monitor an animal once the batteries reach a critically low level. The batteries must be replaced before using the 9847V.

NOTE: Removing batteries may delete memory and all user defined settings, including calendar and clock.

Audible Alarm Disabled Indicator

If the device is turned on with the audible alarms permanently disabled, the yellow Audible Alarm Disabled indicator is steadily lit. If the audible alarms are temporarily disabled, the Audible Alarm Disabled indicator blinks.

After the 9847V is turned on (and after exiting the setup mode, if applicable) and until a pulse oximeter or CO_2 sensor is plugged in for the first time, the Audible Alarm Disabled indicator blinks (or remains steadily lit if the audible alarms are permanently disabled).

The Audible Alarm Disabled indicator cannot be turned off until a sensor is plugged in. (Until a sensor is detected, this is the device's only lit indicator. It provides an "on" indication to the user.) If the audible alarms are not disabled, a 2-minute "temporarily disabled" timer starts the first time a sensor is plugged in after power on. See "Disabling the Audible Alarms" on page 20 for additional information.

Audible Indicators

⚠ **CAUTION:** Do not block the audible indicator speaker holes. Blocking the speakers will significantly reduce the sound volume.

⚠ **CAUTION:** Verify the audible alarms can be heard over the ambient noise of the operating environment.

Audible indicators include medium priority (equipment) alarms, high priority (animal) alarms, and informational tones (breath beeps). For information on disabling the audible alarms, see "Disabling the Audible Alarms" on page 20.

Breath Beep

When the detected CO_2 increases (during exhalation) by approximately 5 mmHg, a breath is detected and the audible breath beep sounds. One beep is sounded for each breath detected. The breath beeps will only sound during the quiet part of an alarm burst sequence.

The "variable pitch" (fixed pitch "off") breath beep is the default setting at setup. During variable pitch breath beep, the tone of the breath beep is indexed to the number of bars lit on the CO_2 bar graph. The more bars lit, the higher the pitch. In variable pitch mode, breath beeps sound at inspiration (on the falling edge of the CO_2 waveform).

However, if desired, the "fixed pitch" breath beep (fixed pitch "on") can be selected at setup. The fixed pitch breath beep has a pitch higher than the highest bar graph-indexed pitch. In fixed pitch mode, breath beeps sound during exhalation (on the rising edge of the CO_2 waveform). During power on initialization and when changing the breath beep sound volume, beeps sound as fixed pitch.

Each time the 9847V is turned on, the breath beep defaults to the medium sound volume setting. During normal operation, pressing the Advance button cycles the breath beep volume between low, medium, high, and off. A "volume" beep will sound each time the Advance button is pressed to indicate the current setting, unless an audible alarm is in progress.

NOTE: The Advance button will not alter the volume of the medium and high priority audible alarms.

Critically Low Battery Alarm

The audible critically low battery alarm is a medium priority equipment alarm indicating the batteries have reached a critically low level and must be replaced immediately. The 9847V will not monitor animals after the batteries reach a critical power level. Also during this medium priority alarm, the visible Low Battery indicator blinks.

If a high priority animal alarm condition exists before reaching critically low battery level, the audible and visible alarms "latch." A "latched" animal alarm condition sounds a high priority animal audible alarm. A high priority animal visible alarm indicator that is "latched" for a critically low battery will either blink (for no breath or pulse quality) or display 3 blinking dashes (for SpO_2 or pulse rate).

⚠ **CAUTION:** The critically low battery state overrides the audible alarm disable switch. If a critically low battery condition occurs and the audible alarms are either temporarily or permanently disabled, the audible alarms will become re-enabled. A medium priority alarm will sound unless there is a high priority alarm condition in effect. The Audible Alarm Disabled indicator will not be lit.

The audible critically low battery alarm cannot be disabled by the alarm disable switch.

SpO_2 High or Low Alarm

The audible SpO_2 alarm is a high priority animal alarm that sounds (if the audible alarms are not disabled) when the SpO_2 high or low alarm limits are reached or exceeded. (Also during this high priority alarm, a visible alarm occurs. See "SpO_2 and Pulse Rate Displays" on page 24 for more information.) The audible and visible indicators stop when the condition is cleared.

Pulse Rate High or Low Alarm

The audible pulse rate alarm is a high priority animal alarm that sounds (if the audible alarms are not disabled) when the pulse rate high or low alarm limits are matched or exceeded. (Also during this high priority alarm, a visible alarm occurs. See "SpO_2 and Pulse Rate Displays" on page 24 for more information.) The audible and visible indicators stop when the condition is cleared.

Pulse Quality Alarm

The audible pulse quality alarm is a high priority animal alarm that sounds (if the audible alarms are not disabled) when the detected pulse signals are of inadequate pulse quality. During this high priority alarm, the Pulse Quality indicator blinks red as it normally does in inadequate pulse quality situations, and can be latched (will continue) for the critical battery state. (See "Pulse Quality Indicator" on page 25 for additional information.) The audible and visible indicators stop when the condition is cleared.

No Breath Alarm

The audible no breath alarm is a high priority animal alarm that sounds (if the audible alarms are not disabled) when a breath has not been detected for a period of time exceeding the set no breath delay time (measured in seconds). Also during this high priority alarm, the No Breath indicator blinks.

If a CO_2 sensor alarm occurs, existing audible and visible No Breath indicators latch (will continue). In most cases, however, during "fixed pitch" breath beep mode, when the airway adapter tube is disconnected from the CO_2 sensor, the audible and visible No Breath indicators stop.

When a breath is again detected, the audible and visible No Breath indicators stop. The no breath delay timer starts when the CO_2 sensor is connected into the 9847V and the system is not in setup mode (i.e., when the lower bar is lit on the CO_2 bar graph).

Pulse Oximeter Sensor Alarm

The pulse oximeter sensor alarm is a medium priority (equipment) audible alarm that sounds when the pulse oximeter sensor is either disconnected, dislodged, or a pulse oximeter sensor failure occurs. Also during this medium priority alarm, visible indicators occur. The audible and visible pulse oximeter sensor alarm indicators stop when the condition is corrected.

CO_2 Sensor Alarm

The CO_2 sensor alarm is a medium priority (equipment) audible alarm. Conditions that may cause the audible equipment alarm include:

- The CO_2 sensor is unplugged.
- The airway adapter tube is removed from the CO_2 sensor.
- The light path is blocked.
- A CO_2 sensor failure occurs.

Also during this medium priority alarm, a visible indication occurs (a CO_2 sensor fault) where the third and sixth bars on the CO_2 bar graph are steadily lit (see "CO_2 Bar Graph" on page 26). The audible and visible CO_2 sensor alarm indicators stop when the condition is corrected.

Audible and Visible Indicator Functions During Alarm Conditions

Table 4 summarizes the audible and visible indications that occur during the equipment and animal alarm conditions.

NOTE: These rules assume the audible alarms have not been temporarily or permanently disabled using the Audible Alarm Disabled button.

Table 4: Audible and Visible Indicator Functions During Alarm Conditions

Alarm Condition	Audible Indication	Visible Indication
Low battery level	None	Low battery indicator steadily lit.
Battery level critically low	Medium priority alarm[a], unless audible high priority animal alarm is latched.	• Battery indicator blinking. • Latched prior high priority animal alarm. • All other visible indicators off (the device is unavailable for use).
SpO_2 high or low	High priority animal alarm	SpO_2 numeric display blinking; if latched for critical battery state, displays blinking dashes in all 3 LEDs.
Pulse rate high or low	High priority animal alarm	Pulse rate numeric display blinking; if latched for critical battery state, displays blinking dashes in all 3 LEDs.
Inadequate pulse quality	High priority animal alarm	Pulse Quality indicator blinks red as it normally does in inadequate pulse quality situations; can be latched for critical battery state.
No breath (no breath detected during set delay time interval measured in seconds)	High priority animal alarm	• No Breath indicator flashing. • CO_2 bar graph remains active. • CO_2 bar graph blank (disabled) during critical battery state.
Pulse oximeter sensor disconnect, dislodgment, or pulse oximeter sensor failure	Medium priority alarm until valid signal again detected, unless audible high priority animal alarm is latched.	• Display "dash" sign in leftmost SpO_2 digit and freeze numeric displays for 10 seconds. • Display dashes in middle digit of SpO_2 and pulse rate displays 10 seconds after first dash. • Corresponding dashes will blink if prior high priority pulse oximeter animal alarms are latched.

Table 4: Audible and Visible Indicator Functions During Alarm Conditions (Continued)

Alarm Condition	Audible Indication	Visible Indication
CO_2 sensor reduced signal due to: • CO_2 sensor disconnection • Malfunction • Blocked light path • Airway adapter tube removed from the CO_2 sensor • Airway adapter tube improperly installed in airway sensor	Medium priority alarm until valid signal again detected, unless audible high priority animal alarm is latched.	• Third and sixth bars of CO_2 display steadily lit. • Latched prior No Breath indicator blinks.

a. Note that if a critical battery condition occurs while the audible alarms are disabled, the audible alarms will become re-enabled. A medium priority alarm will sound unless there is a high priority alarm condition in effect.

Description of Alarm Sounds

The pitch of the alarm sounds is the same as a "volume" beep (the tone heard when changing the breath beep sound volume).

NOTE: Audible alarm volumes are fixed. The audible alarms can be disabled, but the volumes are not user-adjustable.

The sound sequence for the high priority alarm consists of 3 short beeps, a delay, and then 2 more beeps within a 1-second period; then an identical pattern after a 1-second delay. This sound sequence then repeats every 10 seconds until the high priority animal alarm condition is cleared.

The sound sequence for the medium priority alarm consists of 3 medium long beeps within a 1-second period. This sound sequence will repeat every 25 seconds until the medium priority equipment alarm condition is cleared.

Audible Indicator Sound Control Priorities

Only one audible alarm or informational tone may sound at a time. However, more than one type of alarm condition may occur at the same time (e.g., a critical battery condition could begin while a no breath condition is occurring). Therefore, the 9847V software uses a set of rules to determine the priority of these sounds. These sound control rules are described in Table 5.

NOTE: These priorities assume the audible alarms have not been temporarily or permanently disabled using the Audible Alarm Disabled button.

Table 5: Audible Indicator Sound Control Priorities

Condition	Sound Control Priorities
Low Battery Level	Normal sound operation; steadily lit Low Battery indicator only.
• Critically Low Battery Level or • Pulse Oximeter Sensor Alarm or • CO_2 Sensor Alarm (medium priority equipment alarm)	Medium priority audible alarm unless a prior high priority animal alarm is latched. When latched, it will sound a high priority animal alarm. If a critically low battery condition occurs and the audible alarms are either temporarily or permanently disabled, the audible alarms will become re-enabled. A medium priority alarm will sound unless there is a high priority alarm condition in effect. The medium priority sound cycle will not be restarted should a new equipment alarm condition occur; the existing sound will be maintained.
• SpO_2 high or low or • Pulse rate high or low or • Inadequate pulse quality or • No breath (high priority animal alarm)	The onset of a high priority animal alarm condition will cause the initiation of the high priority animal alarm. If a medium priority equipment alarm condition occurs after the onset of a animal alarm condition, the animal alarm state will be latched and will not be overridden by the equipment alarm. When the animal alarm condition is cleared and there is an equipment alarm in effect, then the medium priority sound will be started.
Audible alarms re-enabled via Audible Alarm Disable button or ending of 2-minute disable	When the audible alarms are re-enabled, and at least one alarm condition exists, the sound cycle for the highest priority alarm condition in effect at that time will be started. **Note:** The critically low battery state overrides the audible alarm disable. If a critically low battery condition occurs and the audible alarms are either temporarily or permanently disabled, the audible alarms will become re-enabled. A medium priority alarm will sound unless there is a high priority alarm condition in effect.
Breath beep	Informational beeps will occur only during the "quiet" part of any alarm sound in progress (or the beep volume can be set to OFF).

Carbon Dioxide Sensor and Airway Adapter Tube

WARNING: Do not use a damaged sensor. If the sensor is damaged in any way, discontinue use immediately and replace the sensor.

⚠	CAUTION: Before use, carefully read the Instructions for Use provided with the sensors and airway adapters.

⚠	CAUTION: Water or other liquid between the airway adapter tube and the CO_2 sensor may cause erroneous readings.

⚠	CAUTION: Ensure all connections to the airway adapter tube are tight and leak-free, and that the airway adapter tube is properly attached to the CO_2 sensor.

Carbon Dioxide Sensor

The Model 9840SA CO_2 Sensor is a crescent-shaped device containing light emitting and detecting elements (figure 7) on the end of a cable that connects to the 9847V. The CO_2 sensor is connected onto the Model 9840AAT Airway Adapter Tube, which in turn is connected between the endotracheal tube and the breathing circuit of an intubated animal.

Figure 7: Model 9840SA Carbon Dioxide Sensor

Airway Adapter Tube

WARNING: Do not reuse the Model 9840AAT Airway Adapter Tube. Cleaning the interior will damage the anti-fog coating and cause inaccurate readings or a CO$_2$ sensor alarm.

WARNING: The Model 9840AAT Airway Adapter Tube will increase dead space by approximately 6 cubic centimeters (0.4 cubic inches); this may adversely affect ventilation for animals with small tidal volumes.

⚠ **CAUTION:** Do not use the airway adapter tube if the airway adapter tube is below 5 °C (41 °F). An airway adapter tube that is below 5 °C (41 °F) may frost, causing a false reading. Warm the airway adapter tube to above 5 °C (41 °F) by putting it in a warm place (for example in your hands or in a vehicle) before use.

⚠ **CAUTION:** An airway adapter tube that is between 5 °C (41 °F) and 10 °C (50 °F) may cause inaccurate readings due to fogging of optical surfaces. It is recommended that the airway adapter tube be warmed to above 10 °C (50 °F) before use.

The Model 9840AAT Airway Adapter Tube (figure 8) is a single-use only, disposable adapter designed to be placed between the endotracheal tube and the breathing circuit of intubated animals. The airway adapter tube connects to the CO$_2$ sensor.

The CO$_2$ detector will not function properly unless the light emitting and detecting elements of the CO$_2$ sensor are properly aligned with the windows in the airway adapter tube.

Figure 8: Model 9840AAT Airway Adapter Tube

Attaching the Airway Adapter Tube to the CO$_2$ Sensor

1. While grasping the large end of the airway adapter tube, place the clear windows of the tube toward the CO$_2$ sensor (figure 9-A). The reflector should face away from the CO$_2$ sensor.

NOTE: It is possible to force the airway adapter tube and the CO$_2$ sensor into an improper alignment and connection. However, the CO$_2$ detector will not function properly unless these pieces are correctly attached to each other.

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2. Join the tabs on one side of the airway adapter tube onto either side of the CO_2 sensor (figure 9-A), then rotate the airway adapter tube (figure 9-B) and push firmly to set the other pair of tabs. You should hear a clicking sound as the pieces are connected together (figure 9-C).

A   **B**   **C**

(Note: The ends of the airway adapter tube can be placed in either direction relative to the CO_2 sensor.)

Figure 9: Connecting the Airway Adapter Tube to the CO_2 Sensor

3. Ensure the airway adapter tube and the CO_2 sensor are firmly attached to each other. Gently tug on the assembly to make sure the pieces are tightly connected.

NOTE: Both sides of the airway adapter tube must be connected onto the CO_2 sensor. If only one side of the airway adapter tube is attached to the CO_2 sensor, the pieces will come apart and will cause a CO_2 sensor alarm.

The airway adapter tube attaches between the endotracheal tube of the animal and the breathing circuit. See Figure 10 for an illustration of the configuration.

NOTE: Not all tapered connectors are compatible with the airway adapter tube. Ensure all connections are secure.

Breathing Circuit (a breathing device, breathing bag, ventilator, etc.)

9847V

Model 9840SA CO_2 sensor

Model 9840AAT Airway Adapter Tube

Endotracheal Tube

Figure 10: Airway Adapter Tube and the Breathing Circuit

Care and Maintenance

Wipe the device with a soft cloth dampened with a mild detergent or 10% bleach solution. Do not use undiluted bleach or any cleaning solution other than those recommended here, as permanent damage could result. Dry with a soft cloth, or allow to air dry.

Clean the device separately from the sensors. For instructions on cleaning pulse oximeter sensors, refer to the respective sensor instructions for use.

> ⚠ **CAUTION:** Do not place the Model 9847V in liquid or clean it with agents containing ammonium chloride, isopropyl alcohol, or products that are not listed in this User's Guide.

Maintenance

The 9847V requires no routine calibration or maintenance, other than battery replacement.

> ⚠ **CAUTION:** Do not use caustic or abrasive cleaning agents on the device or the sensors.

> ⚠ **CAUTION:** Do not autoclave or immerse the device or sensors in liquid. Do not expose the device or components to excessive moisture or liquids.

The Oxitest^{Plus7} by Datrend Systems, Inc. can be used to verify operation of the pulse oximeter.

Cleaning the CO_2 Sensor

> ⚠ **CAUTION:** Do not immerse the CO_2 sensor in liquid, and do not use caustic or abrasive cleaning agents on the CO_2 sensor.

The CO_2 sensor is protected against splashing water.

Clean the Model 9840SA CO_2 Sensor with a soft cloth dampened with isopropyl alcohol. Do not pour or spray any liquids onto the Model 9840SA CO_2 Sensor. Allow the Model 9840SA CO_2 Sensor to dry thoroughly before reusing.

Returning the CO_2 Sensor for Service

If the Model 9840SA CO_2 Sensor must be returned to Nonin for service, the product should be free of any contaminants, and sterilization may be required. Contact Nonin's Customer Support department for shipping instructions.

Memory Functions

Memory

The 9847V can collect and store up to 24 hours of SpO_2 and pulse rate information.

NOTE: CO_2 detector data is not stored in memory.

Software to download stored pulse oximetry data is available for use with PCs. Contact Nonin Technical Support for information.

The solid-state memory in the device functions much like an endless loop. When the memory fills up, the unit begins overwriting the oldest locations with the latest data.

Each time the device is turned on, the current time/date information (if the clock is set properly) is stored in memory to allow quick differentiation of recording sessions. Animal SpO_2 and pulse rate are sampled and stored every 4 seconds. The oxygen saturation values are stored in 1% increments in the range of 0 to 100%. The stored pulse rate ranges from 18 to 300 pulses per minute. The stored values have increments of 1 pulse per minute from 18 to 200 pulses per minute, and increments of 2 pulses per minute from 201 to 300 pulses per minute.

NOTE: The 9847V can not store pulse rates greater than 300 pulses per minute in memory. All detected pulse rates greater than 300 pulses per minute are truncated and saved as 300 pulses per minute in memory.

During data retrieval, the last data recorded is the first displayed. For example, the last 4 minutes of data recorded are the first 4 minutes displayed.

Recording Sessions

Each time the device is turned on (except while setting the clock) data is automatically collected.

NOTE: Only recording sessions greater than 1 minute in length are kept in memory for later printing.

Memory Playback Mode

1. With the unit off, press and hold **Alarm Limit Review** while pressing and then releasing **On/Standby**.
2. Release **Alarm Limit Review** when 888 888 displays on the SpO_2 and pulse rate displays. Three brief beeps sound and ALr and dFt appear in the SpO_2 and pulse rate displays.
3. Data will be automatically played back from the memory.

NOTE: The keypad sequence for starting memory playback is identical to the sequence used for entering setup mode.

Data are played back at a rate of 20 minutes of collected data per second. A 24-hour recording session (the maximum memory saved) is played back in approximately 1 minute. After all data are played back, the device should be shut off before collecting new animal data. The animal information is held in memory as long as the batteries are good, so if the memory must be cleared, remove the batteries for a period of 60 seconds or longer. Playing back the data in memory does not clear any data from the memory.

The size of this file depends on the amount of data saved in the memory. The most recent data are played back first. The memory data format is in binary. Bad data is represented by FF (hexadecimal) or 255 (decimal). If the memory "wrapped around" (the recording time exceeded 24 hours) and the final (i.e., the oldest) file of data has been truncated, the final start time will be represented by zeroes and the start times for that file will then not match up.

Communications

Real-Time Serial Output

The 9847V provides real-time data output capability via the pulse oximeter sensor connector (a 9-pin Sub-D connector). The sensor connector pin assignments are listed in table 6.

Table 6: Pulse Oximeter Sensor Connector Pin Assignments

Pin Number	Assignment
1	Sensor Detect
2	IR Drive
3	Red Drive
4	Serial Data Output
5	Signal
6	Sensor Type
7	Ground
8	NC
9	Sensor Bias

Real-time data can also be transmitted to another device through the serial data infrared link (sensor connector) at the top of the device. Refer to figure 2 on page 7 for the location of the sensor connector.

The information from the device in the real-time mode is sent in an ASCII serial format at 9600 baud with 9 data bits, 1 start bit, and 1 stop bit. The data are output at a rate of once per second.

NOTE: The 9th data bit is used for parity in memory playback mode. In real-time mode, it is always set to the mark condition. Therefore, the real-time data may be read as 8 data bits, no parity.

Real-time data may be printed or displayed by compatible devices. On power up a header is sent identifying the format and the time and date. Thereafter, the data are sent once per second by the device in the following format:

HH:MM:SS   SPO2=XXX   HR=YYY

NOTE: Marked events will display as an asterisk (*) at the end of the line.

Where:

- "HH" represents the hour set on the real-time clock
- "MM" represents the minutes
- "SS" represents the seconds
- "XXX" represents the SpO_2 value
- "YYY" represents the pulse rate

The SpO_2 and pulse rate will be displayed as "---" if there are no data available for the data reading.

If a breath was detected in the previous interval a "B" will be appended to the data line.

Connecting the Device into a Medical System

Incorporating the device into a medical system requires the integrator to identify, analyze, and evaluate the risks to patient, operators, and third parties. Subsequent changes to the medical system after device integration could introduce new risks and will require additional analysis. Changes to the medical system that must be evaluated include:

• Changing the system configuration

• Adding devices to or disconnecting devices from the system

• Updating or upgrading equipment connected to the system

Issues resulting from user-initiated system changes may include corruption or loss of data.

NOTES:
• When using the serial port to connect the device to other equipment, follow each device's cleaning instructions.
• Verify all equipment connected to the device is suitable for the patient's environment.

⚠ **CAUTION:** Failure of a network data coupling (serial cable/connectors/wireless connections) will result in loss of data transfer.

Service, Support and Warranty

> ⚠ **CAUTION:** This device is a precision electronic instrument and must be repaired by trained Nonin personnel only. Field repair of the device is not possible. Do not attempt to open the case or repair the electronics. Opening the case may damage the device and void the warranty.

> ⚠ **CAUTION:** Any sign or evidence of opening the system, field service by non-Nonin personnel, tampering, or any kind of misuse or abuse of the system, shall void the warranty in its entirety.

The advanced digital circuitry within the Model 9847V requires no periodic maintenance or calibration. Nonin does not recommend field repair of the Model 9847V.

For additional technical information, contact Nonin's Technical Service department at:

Nonin Medical, Inc.
13700 1st Avenue North
Plymouth, Minnesota 55441-5443 USA

(800) 356-8874 (USA and Canada)
+1 (763) 553-9968
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E-mail: technicalservice@nonin.com

Nonin Medical B.V.
Prins Hendriklaan 26
1075 BD Amsterdam, Netherlands

+31 (0)13 - 79 99 040 (Europe)
Fax: +31 (0)13 - 79 99 042
E-mail: technicalserviceintl@nonin.com

nonin.com

All non-warranty work shall be done according to Nonin standard rates and charges in effect at the time of delivery to Nonin. All repairs include a complete retest of the Model 9847V using factory test fixtures.

Warranty

NONIN MEDICAL, INCORPORATED, (Nonin) warrants to the purchaser, for a period of 3 years from the date of purchase, each Model 9847V Veterinary Pulse Oximeter and CO_2 Detector exclusive of sensors, cables, and batteries. (Refer to the individual package inserts for specific warranty information for sensors, cables, and other accessories.) Nonin shall repair or replace any Model 9847V found to be defective in accordance with this warranty, free of charge, for which

Nonin has been notified by the purchaser by serial number that there is a defect, provided said notification occurs within the applicable warranty period. This warranty shall be the sole and exclusive remedy by the purchaser hereunder for any Model 9847V delivered to the purchaser which is found to be defective in any manner whether such remedies be in contract, tort or by law.

This warranty excludes cost of delivery to and from Nonin. All repaired units shall be received by the purchaser at Nonin's place of business. Nonin reserves the right to charge a fee for a warranty repair request on any unit found to be within specifications.

The Model 9847V is a precision electronic instrument and must be repaired by knowledgeable and specially trained Nonin personnel only. Accordingly, any sign or evidence of opening the Model 9847V, field service by non-Nonin personnel, tampering, or any kind of misuse or abuse of the Model 9847V, shall void the warranty in its entirety.

All non-warranty work shall be done according to Nonin standard rates and charges in effect at the time of delivery to Nonin.

DISCLAIMER/EXCLUSIVITY OF WARRANTY:

THE EXPRESS WARRANTIES SET FORTH IN THIS MANUAL ARE EXCLUSIVE AND NO OTHER WARRANTIES OF ANY KIND, WHETHER STATUTORY, WRITTEN, ORAL, OR IMPLIED INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY SHALL APPLY.

Accessories

The following Nonin accessories function with Model 9847V. Detailed information regarding specific sensor use (animal population, body/tissue, and application) can be found in the respective sensor Instructions for Use.

Model Number	Description
Carbon Dioxide Sensor Assembly	
9840AAT	Airway Adapter Tube, 12 per box
9840SA	Carbon Dioxide Sensor
Veterinary Pulse Oximeter Reusable Sensors	
2000SL	Lingual Clip Sensor
2000SA	Small Animal Flex Sensor
2000T	Transflectance Sensor
Other Accessories	
HH-CC	Carrying Case
8500MB	Mounting Bracket
8500MB-PMS	Mounting Bracket (w/Pole Mount System - includes Pole Mount side bracket and Pole Mount clamp)
8500RB	Rubber Bumper
8500TS	Tabletop Stand
PC	Pole Mount Clamp
UNI-EXT-1	Extension Cable, 1 meter (3 feet)
UNI-EXT-3	Extension Cable, 3 meters (10 feet)
UNI-EXT-6	Extension Cable, 6 meters (20 feet)
UNI-EXT-9	Extension Cable, 9 meters (30 feet)
1000MC	Memory Cable (for use between Model 9847V and a PC running Microsoft Windows® operating systems)
1000RTC	Serial Cable, Real-Time
1000USB	USB Interface Adapter
1000USB-C	USB Interface Adapter (Continua™)

For more information about Nonin parts and accessories contact your distributor, or contact Nonin at (800) 356-8874 (USA and Canada),+1 (763) 553-9968, or +31 (0)13 - 79 99 040 (Europe).

> **WARNING: The use of accessories, sensors, and cables other than those specified may result in increased emission and/or decreased immunity of this device.**

> **WARNING: To avoid injury to the animal, use only with Nonin-branded PureLight® pulse oximeter sensors. These sensors are manufactured to meet the accuracy specifications for Nonin Pulse Oximeters. Using other manufacturers' sensors can result in improper pulse oximeter performance.**

![Nonin logo]

Troubleshooting

Problem	Possible Cause	Possible Solution
The device won't turn on.	Batteries are depleted.	Replace all six batteries.
	Batteries are installed incorrectly.	Verify battery orientation, as illustrated inside battery compartment or on device label.
The Low Battery indicator is steadily lit or flashing.	Battery level is low or critically low.	Replace all six batteries.
	Incorrect battery installation.	Verify correct battery orientation.
A dash appears in the leftmost position of the SpO_2 display.	A SpO_2 sensor fault exists (disconnect, failure, misalignment, or incompatibility with the monitor).	Verify Nonin-branded sensor is correctly connected to the device and the animal; replace sensor if condition persists.
	A non-compatible SpO_2 sensor is being used.	Replace sensor with a Nonin-branded Purelight sensor.
The middle digits display dashes in both the SpO_2 and Pulse Rate displays.	No SpO_2 signal is detected.	Verify sensor connection.
	A sensor failure.	Replace sensor with a Nonin-branded Purelight sensor.
The displayed pulse rate does not correlate to the pulse rate displayed on the ECG monitor when used together.	Excessive motion at sensor site may be prohibiting device from detecting a consistent pulse signal.	Eliminate or reduce the cause of the motion **or** reposition sensor to a new sensor site.
	Animal may have an arrhythmia resulting in some heart beats that do not detect a pulse quality signal at the sensor site.	Assess the animal.
	Non-compatible sensor is being used.	Replace sensor with a Nonin-branded Purelight sensor.
	ECG monitor may not be functioning properly.	Assess the animal.
An inconsistent pulse rate or a yellow Pulse Quality indicator during use with electrosurgical unit (ESU).	ESU may be interfering with pulse oximeter performance.	Assess the animal. Move device, cables, and sensors as far away from the ESU as possible.

Problem	Possible Cause	Possible Solution
The Pulse Quality indicator blinks yellow with each pulse.	Quality of pulse signal at sensor site is inadequate.	Assess the animal. Reposition sensor **or** select an alternate sensor site.
Pulse Quality indicator does not blink green.	Inadequate pulse signal **or** the sensor site is poorly perfused **or** the sensor is not correctly positioned.	Reposition sensor.
	Sensor is restricting blood circulation at sensor site.	Remove restriction to increase blood circulation at sensor site **or** relocate sensor.
	Circulation is reduced due to excess pressure between the sensor and a hard surface.	Allow sensor and tongue/tissue to rest comfortably on the surface.
	Excessive ambient light.	Reduce ambient light.
	Excessive animal motion.	Reduce animal motion.
	Performance degradation from: • arterial catheter • blood pressure cuff • electrosurgical procedure • infusion line	Reduce or eliminate source.
The Pulse Quality indicator blinks red and the SpO_2 and/or pulse rate displays are dashes.	Inadequate pulse signal at sensor site.	Assess the animal. Reposition sensor **or** select an alternate sensor site.
	Inadequate pulse signal due to excessive motion.	Reduce animal motion. Reposition **or** relocate sensor.
	SpO_2 sensor failure.	Replace SpO_2 sensor.
Numeric display segments are missing.	Defective LEDs.	Discontinue use of the device.
The lower CO_2 bar is not lit.	CO_2 sensor is not plugged in.	Plug CO_2 sensor in.

Problem	Possible Cause	Possible Solution
Only the third and sixth CO_2 bars are lit.	CO_2 sensor has become disconnected.	Reconnect CO_2 sensor.
	Airway adapter tube is not connected to the CO_2 sensor.	Verify airway adapter tube is connected, with windows toward the sensor.
	Light path is blocked.	Replace airway adapter tube.
	CO_2 sensor lamp is burned out.	Replace CO_2 sensor.
Degradation of device performance.	Electromagnetic interference (EMI).	Remove device from the EMI environment.

Note: If these solutions do not correct the problem with your device, please contact Nonin Technical Service at (800) 356-8874 (USA and Canada), +1 (763) 553-9968, or +31 (0)13 - 79 99 040 (Europe).

Technical Information

NOTE: This product complies with ISO 10993-1, Biological Evaluation of Medical Devices Part 1: Evaluation and Testing.

⚠ **CAUTION:** A functional tester cannot be used to assess the accuracy of a pulse oximeter monitor or sensor.

⚠ **CAUTION:** All parts and accessories connected to the serial port of this device must be certified according to at least IEC Standard 60950 or UL 1950 for data-processing equipment.

⚠ **CAUTION:** Portable and mobile RF communications equipment can affect medical electrical equipment.

Manufacturer's Declaration

Refer to the following table for specific information regarding this device's compliance to IEC 60601-1-2.

Table 7: Electromagnetic Emissions

Emissions Test	Compliance	Electromagnetic Environment—Guidance
This device is intended for use in the electromagnetic environment specified below. The user of this device should ensure that it is used in such an environment.		
RF Emissions CISPR 11	Group 1	This device 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	This device 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.
Harmonic Emissions IEC 61000-3-2	N/A	
Voltage Fluctuations/ Flicker Emissions IEC 61000-3-3	N/A	

Table 8: Electromagnetic Immunity

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment—Guidance
This device is intended for use in the electromagnetic environment specified below. The user of this device should ensure that it is used in such an environment.			
Electrostatic Discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical Fast Transient/Burst IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines	N/A N/A	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	N/A N/A	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions, and voltage variations on power supply input lines IEC 61000-4-11	±5% U_T (>95% dip in U_T) for 0.5 cycle ±40% U_T (60% dip in U_T) for 5 cycles ±70% U_T (30% dip in U_T) for 25 cycles <5% U_T (>95% dip in U_T) for 5 sec.	N/A	Mains power quality should be that of a typical commercial or hospital environment. If the user of the device requires continued operation during power mains interruptions, it is recommended that the device be powered from an uninterruptible power supply or battery pack.
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: U_T is the AC mains voltage before application of the test level.			

Table 9: Guidance and Manufacturer's Declaration—Electromagnetic Immunity

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment— Guidance
This device is intended for use in the electromagnetic environment specified below. The user of this device should ensure that it is used in such an environment.			
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.			
Conducted RF IEC 61000-4-6 Radiated RF IEC 61000-4-3	3 Vrms 150 kHz to 80 MHz 3 V/m 80 MHz to 1.0 GHz 3 V/m 1.0 GHz to 2.5 GHz	3 V 3 V/m 3 V/m[a] 0.5 V/md[b]	**Recommended Separation Distance** $d = 1.17\sqrt{P}$ $d = 1.17\sqrt{P}$ $d = 2.33\sqrt{P}$ 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). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[c], should be less than the compliance level in each frequency range.[d] Interference may occur in the vicinity of equipment marked with the following symbol: $$\left(\!\left(\!\left(\underset{\blacktriangle}{\cdot}\right)\!\right)\!\right)$$
NOTES: • At 80 MHz and 800 MHz, the higher frequency range applies. • These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.			

a. SpO_2 and HR operate as intended.

b. Breath detection is affected at fields greater than specified level.

c. 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.

d. Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.

Table 10: Recommended Separation Distances

| This table details the recommended separation distances between portable and mobile RF communications equipment and this device. |

This device is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. Users of this device can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communication equipment (transmitters) and the device as recommended below, according to maximum output power of the communications equipment.

Rated Maximum Output Power of Transmitter W	Separation Distance According to Frequency of Transmitter		
	150 kHz to 80 MHz $d = 1.17\sqrt{P}$	80 MHz to 800 MHz $d = 1.17\sqrt{P}$	800 MHz to 2.5 GHz $d = 2.33\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.37	0.37	0.74
1	1.2	1.2	2.3
10	3.7	3.7	7.4
100	12	12	23

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.

NOTES:
- At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.
- These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.

Equipment Response Time

If the signal from the sensor is inadequate, the last measured SpO_2 and pulse rate values freeze for 10 seconds and are then replaced with dashes.

SpO_2 Values	Average	Latency
Standard/Fast Averaged SpO_2	4 beat exponential	2 beats

Pulse Rate Values	Response	Latency
Standard/Fast Averaged Pulse Rate	4 beat exponential	2 beats

Equipment Delays	Delay
Display Update Delay	1.5 seconds
Alarm Signal Generation Delay	0 seconds

Example - SpO$_2$ Exponential Averaging

SpO_2 decreases 0.75% per second (7.5% over 10 seconds)

Pulse Rate = 75 BPM

Specific to this example:

• The response of the 4-beat average is 1.5 seconds.

![NONIN logo]

Testing Summary

SpO$_2$ accuracy, and low perfusion testing was conducted by Nonin Medical, Inc., as described below:

SpO$_2$ Accuracy Testing

SpO$_2$ accuracy testing is conducted during induced hypoxia studies on healthy, non-smoking, light- to dark-skinned human subjects during motion and no-motion conditions in an independent research laboratory. The measured arterial hemoglobin saturation value (SpO$_2$) of the sensors is compared to arterial hemoglobin oxygen (SaO$_2$) value, determined from blood samples with a laboratory co-oximeter. The accuracy of the sensors in comparison to the co-oximeter samples measured over the SpO$_2$ range of 70 to 100%. Accuracy data is calculated using the root-mean-squared (A$_{rms}$ value) for all subjects, per ISO 80601-2-61, Medical Electrical Equipment—Particular requirements for the basic safety and essential performance of pulse oximeter equipment for medical use.

Pulse Rate Motion Testing

This test measures pulse rate oximeter accuracy with motion artifact simulation introduced by a pulse oximeter tester. This test determines whether the oximeter meets the criteria of ISO 80601-2-61 for pulse rate during simulated movement, tremor, and spike motions.

Low Perfusion Testing

This test uses an SpO$_2$ Simulator to provide a simulated pulse rate, with adjustable amplitude settings at various SpO$_2$ levels for the oximeter to read. The oximeter must maintain accuracy in accordance with ISO 80601-2-61 for heart rate and SpO$_2$ at the lowest obtainable pulse amplitude (0.3% modulation).

Principles of Operation

Pulse oximetry is a non-invasive method that passes red and infrared light through perfused tissue and detects the fluctuating signals caused by arterial pulses. Well-oxygenated blood is bright red, while poorly oxygenated blood is dark red. The pulse oximeter determines functional oxygen saturation of arterial hemoglobin (SpO$_2$) from this color difference by measuring the ratio of absorbed red and infrared light as volume fluctuates with each pulse.

Specifications

Oxygen Saturation Display Range	0 to 100% SpO_2
Pulse Rate Display Range	18 to 450 beats per minute (BPM)
CO_2 Range	0 to >75mmHg
CO_2 Response Time	250 ms
Respiration Rate Range	1 to 60 breaths per minute
Breath Detection Threshold	5 mmHg
Saturation Declared Accuracy (A_{rms})*	70 - 100% ±3 digits for the Model 2000SL, 2000SA, and 2000T sensors. Below 70% is not specified for all sensors.
Pulse Rate Declared Accuracy (A_{rms})*	± 3% ± 1 digit
$\triangle CO_2$ Accuracy of Bar Graph Thresholds (A_{rms})*	±25% of reading (typical)
Measurement Wavelengths and Output Power**	
Red:	660 nanometers @ 0.8 mW max. avg.
Infrared:	910 nanometers @ 1.2 mW max. avg.
Alarm Volume Range:	70–71 dBA
Indicators	
Pulse Quality Indicator:	LED, tricolor
Numeric Displays:	3-digit, 7-segment LEDs, tricolor
CO_2 Bar Graph:	8-segment bar graph, red
Low Battery Indicator:	Dedicated icon, yellow
No Breath Indicator:	Dedicated icon, red
Audible Alarm Disabled Indicator:	Dedicated icon, yellow
Audible Indicator:	Miniature speaker

* ± 1 A_{rms} represents approximately 68% of measurements.

** This information is especially useful for clinicians performing photodynamic therapy.

NONIN

Temperature (Operating)	
Pulse Oximeter:	-20 °C to +50 °C (-4 °F to +122 °F)
CO_2 Detector:	0 °C to +50 °C (32 °F to +122 °F)
Temperature (Storage/Transportation):	-40 °C to +70 °C (-40 °F to +158 °F)
Humidity (Operating)	10% to 95% noncondensing
Humidity (Storage/Transportation):	10% to 95% noncondensing
Altitude (Operating)	Up to 3,000 meters (10,000 feet)
Altitude (Hyperbaric Pressure):	Up to 4 atmospheres
Power Requirements	Six 1.5V AA-size alkaline batteries
	90 hours - Pulse Oximeter only
	20 hours - CO_2 and Pulse Oximeter
	24 hours - CO_2 only
Dimensions	8 cm W x 15 cm H x 2.5 cm D
	(3 in. W x 6 in. H x 1 in. D)
Weight	310 g (11 oz) (with alkaline batteries)
Classifications per IEC 60601-1 / CAN/CSA-C22.2 No. 601-1 / UL60601-1	
Type of Protection:	Internally powered (on battery power)
Degree of Protection:	Type BF-Applied Part
Mode of Operation:	Continuous
Enclosure Degree of Ingress Protection	IP32

This device is not made with natural rubber latex.