NONIN®

Operator's Manual

Models 8600V & 8600MV
Veterinary Pulse Oximeters

About the Manual

There are many contraindications, warnings, and cautions throughout this manual.
Read them carefully before using the 8600V.

Trademarks

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References

References to "NONIN" in this manual shall imply NONIN Medical, Inc.

References to "8600V" in this manual shall imply Model 8600V and 8600MV.

The information in this manual has been carefully checked and is believed to be accurate. In the interest of continued product development, 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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Nonin Medical, Inc.
13700 1st Avenue North
Plymouth, MN 55441-5443 USA

• (763) 553-9968   • (800) 356-8874 (USA and Canada)
• FAX (763) 553-7807
• E-mail: mail@nonin.com • http://www.nonin.com

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Guide to Symbols

SYMBOL	DEFINITION OF SYMBOL
⚠	**ATTENTION:** Consult Accompanying Documents
$C \in$	Conformance to EC directive No. 89/336//EEC concerning EMC
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 30EM and CAN/CSA C22.2 No. 601.1.
⌧	Indicates separate collection for electrical and electronic equipment (WEEE).

Precautions for Use

Contraindications
- Do not operate the 8600V in an explosive atmosphere.
- The MODEL 8600V is intended for VETERINARY USE ONLY. Do not use on human patients.

Warnings
- Use only NONIN MODEL 8600V compatible veterinary accessories.
- Do not set the Alarm volume too low to be heard. Doing so could compromise Animal safety.
- Accurate oxygen saturation measurement cannot be obtained when the oximeter is not measuring the pulse properly. If the Perfusion LED is erratic or the Pulse Rate display is erratic or inaccurate, *first examine the Animal for any signs of distress and only then reexamine sensor placement.*
- Inadequate perfusion, thick fur or foreign matter that blocks light or an improperly applied sensor can result in erratic and inaccurate oxygen saturation and/or pulse rate measurement. Follow the instructions outlined in "Verifying Operation". If proper operation cannot be verified, remove the sensor from the Animal and *do not* use the oximeter on this Animal.
- In the event the sensor becomes dislodged from the Animal, audible and visual alarms are activated requiring that a veterinary professional investigate the reason for the alarm status. *The veterinary professional must investigate Animal status and sensor attachment after every sensor alarm indication.* It is possible when the sensor is dislodged from the Animal (under certain conditions of light and vibration of the sensor) for the pulse oximeter to display normal physiological values.
- Use only NONIN fiber optic sensor/cable in MRI environment. Use of sensor/cable containing electrical conductors may cause burns to animals.
- FOR MRI OPERATIONS: Keep oximeter, battery charger and metal end of fiber optic cable beyond the distance of magnetic attraction. Use the 8600 Pole Mount System or comparable device to secure monitor in MRI environment.
- Do not operate the 8600V in the MRI environment while connected to A/C power. The battery charger contains a large amount of ferrous material. Remove the 8600V from the MRI environment to recharge the battery.
- Because the printer, printer interface, and other recording devices contain ferrous materials, do not use in the MRI environment. The 8600MV will store patient data in memory for printing at a later time away from the MRI environment.
- Use only NONIN manufactured veterinary sensors. These sensors are manufactured to meet the calibration requirements for NONIN pulse oximeters. Use of other manufacturer's sensors may cause improper pulse oximeter performance.
- Do not remove any covers. There are no user serviceable parts inside. Refer service to qualified NONIN personnel.
- 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.
- The use of accessories, sensors, and cables other than those listed in this manual may result in increased emission and/or decreased immunity of this device.

Cautions

- This equipment complies with International Standard EN 60601-1-2:2001 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 in this manual.

- Read this manual carefully before using the NONIN Model 8600V veterinary pulse oximeter.

- Cardiogreen and other intravascular dyes, depending on concentration, may affect the accuracy of the SpO_2 measurement.

- The NONIN Model 8600V pulse oximeter is calibrated to determine the percentage of arterial oxygen saturation of functional hemoglobin measured at the fingertip of an adult human. Significant levels of dysfunctional hemoglobins such as carboxyhemoglobin or methemoglobin may affect the accuracy of the measurement. Other types of hemoglobin and alternate sensor locations may affect the calibration.

- Certain pharmacological 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 veterinarian 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 sensor, make sure not to secure the sensor in a manner that will restrict perfusion. This could inhibit proper function of the oximeter and cause discomfort or localized ischemia to the animal.

- If the sensor is not positioned on a perfused site, or at least ten seconds of green perfusion pulses cannot be observed for a given sensor, change sensor location or sensor type until this condition is achieved.

- Be sure to follow instructions for proper connection of 8600VI cable to monitor and sensors. Improper application will prevent proper function of the monitor system.

- The fiber optic cable contains *glass* fibers. Care must be taken when handling the cable. Do not bend sharply, step on, pull, drop, or stretch the fiber optic cable.

- Measurements may be affected in the presence of magnetic resonance imaging (MRI) and computed tomography (CT) devices. It is the facility's responsibility to verify performance prior to installing equipment in these environments.

- Do not immerse the 8600V or NONIN sensors in liquid to clean.

- Do not use caustic or abrasive cleaning agents on the 8600 or NONIN sensors.

- The 8600V is sensitive and must be repaired by knowledgeable and specially trained personnel only.

- This device has not been tested for immunity to electromagnetic disturbances.

- Portable and mobile RF communications equipment can affect medical electrical equipment.

- 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.

Manufacturer's Declaration

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

Table 1: Electromagnetic Emissions

Emissions Test	Compliance	Electromagnetic Environment— Guidance
This device is intended for use in the electromagnetic environment specified below. The customer and/or 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	

Unpacking Your Pulse Oximeter

Contact the carrier immediately if the shipping carton for the 8600V is damaged. Carefully unpack the pulse oximeter and its accessories, and confirm that the items listed below are packed with the 8600V Pulse Oximeter. The 8600V/8600MV shipment includes the following:

- 8600V or 8600MV Pulse Oximeter
- A/C Battery Charger
- Operator's Manual on CD-ROM for Models 8600V and 8600MV
- 8600VI Interface Cable
- 2000SL Lingual Sensor

If any item on this list is missing or damaged, do not use the pulse oximeter. Contact your local distributor or, if you do not know your local distributor, contact NONIN at (800) 356-8874 or (763) 553-9968.

Introduction

Indications for Use

The 8600V Pulse Oximeter is intended to monitor oxygen saturation and pulse rate of animals in hospital environments.

General

The 8600V is a small, lightweight, and portable pulse oximeter with audible and visual alarms for monitoring animal status. The 8600V may be connected to A/C power or run from its internal battery. It typically operates for 30 hours on a fully charged battery. *The 8600V requires no routine calibration or maintenance.*

The 8600V determines arterial oxyhemoglobin saturation (SpO_2) by measuring the absorption of red and infrared light passed through 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 are displayed on light emitting diode (LED) digital displays. On each detected pulse, the perfusion (〰️) indicator flashes. Animal perfusion signals are graded as good, marginal, or inadequate and are indicated by the 〰️ indicator flashing green, yellow, or red, respectively. This simple method gives the user a pulse-by-pulse visual indication of waveform signal quality without requiring complex waveform analysis during critical animal care situations.

Sensor disconnect or malfunction is indicated by lack of good perfusion flashes and/or the red **SENSOR** indicator on the front panel illuminating. Ultimately, if adequate perfusion pulses are not received, the SpO_2 and pulse rate numerical values will be replaced by dashes.

Operating Instructions

Battery Charging

If portable operation is not necessary, continuously charging with the proper battery charger is recommended. The battery charger plugs into the back of the 8600V where it is marked "BATTERY CHARGER". This will assure a fully charged battery should portable operation be required.

The battery charger requires 15 hours to recharge a completely depleted battery pack. While the battery charger is connected to AC power, the green ▭ indicator will be illuminated, and the pulse oximeter may be operated during this time if the red ⊠ indicator is not illuminated when the unit is turned on. If the red ⊠ indicator is illuminated when the unit is turned on, the battery must charge until the red ⊠ is no longer illuminated before it may be used.

The battery pack in the 8600V will typically power the unit for 30 hours with a full charge without needing to be charged.

The 8600V indicates when the battery is low by illuminating the ⊠ indicator in red.

Connecting the Cable and Sensors

Connect the interface cable (Model 8600VI) to the 9-pin female latching sensor connector on the front of the 8600V shown in Figure I. Connect the sensor to the patient interface cable. Position the appropriate sensor on the animal.

Turning On the Pulse Oximeter

Turn on the 8600V by pressing the " | " power switch on the front of the pulse oximeter. Refer to Figure I.

When the 8600V is powered on, the displays will cycle through the following sequence before displaying valid data values:

- **"888 888"** (8600V) or **"888 EEE"** (8600MV)
- current time in hours and minutes saved in memory
- software revision number
- " ▬ ▬ "
- SELF TEST indicator illuminates
- SENSOR indicator illuminates
- ⊠ indicator illuminates

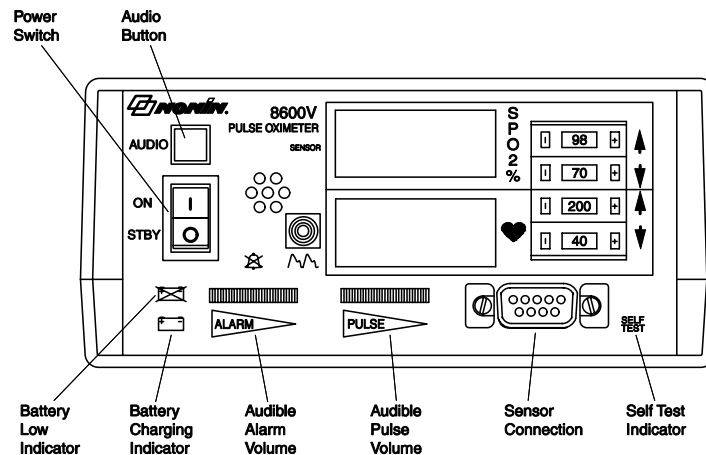***NOTE:*** *If this sequence does not complete properly, do not use the oximeter. Call NONIN Customer Support.*

Figure I: Front View of the 8600V

Verifying Operation

CAUTION! **The 8600V must be able to measure the pulse properly to obtain accurate SpO$_2$ measurement. Verify that nothing is hindering the pulse measurement before relying on the SpO$_2$ measurement.**

Verify that the sensor is properly positioned. Ensure the system is sensing adequate perfusion by observing that the ∿ indicator is blinking green and correlates to the pulse rate for 10 seconds. If the perfusion light is red, yellow, or flashing erratically, reposition the sensor or try a different sensor.

CAUTION! **The use of Xylazine or Detomidine will reduce perfusion sensed by the pulse oximeter and may inhibit SpO$_2$ measurement.**

For the first 2 minutes of operation, the ⌧ indicator will flash to indicate the audible alarm is temporarily disabled during power on. During the first two minutes, the audible alarm may be enabled by pressing the **AUDIO** button. If the audible alarm is not permanently disabled, the ⌧ indicator will not be illuminated after the first 2 minutes of operation and the audible alarm will be enabled.

If the alarm is permanently disabled, the ⌧ indicator will illuminate continuously, and pressing the **AUDIO** button will not have any effect on the audible alarm.

Cleaning the Pulse Oximeter

CAUTION! **Do not immerse the 8600V in liquid to clean, and do not use caustic or abrasive cleaning agents.**

The 8600V Pulse Oximeter may be cleaned with a mild detergent and a soft cloth or with an isopropyl alcohol wipe. Allow enough time for the 8600V to dry thoroughly before reusing.

Features

Controls

All functions of the 8600V are controlled by switches found on the front and rear of the unit.

Power Switch

Pressing the power switch ON ("**|**") causes power to be applied to all internal circuitry. Pressing the power switch to STBY ("**O**") causes power to be removed from the displays and puts the pulse oximeter into a low power standby mode.

AUDIO *Button*

This button has 4 different functions, which are indicated in Table I with directions for use and activation:

Function	How to Activate
Audible Alarm Enable/Disable	Momentary press during normal operation
Sensor Indicator	Momentary press after sensor alarm condition has occurred
Calibrate Recorders	Hold for more than 5 seconds during normal operation
Memory Playback (8600MV only)	Hold for less than 2 seconds during power up
Real-time Setup Mode	Hold for more than 2 seconds during power up

Table I: **AUDIO**   Button Functions

Audible Alarm Enable/Disable

Momentarily pressing the **AUDIO** button disables the audible alarm for 2 minutes. Pressing this button again will override the 2-minute period, re-enabling the audible alarm.

> **NOTE:** *Pressing this button has no effect if the audible alarm has been permanently disabled.*

Calibrate Recorders

When using a strip-chart recorder for outputting data, calibration between the recorder and the 8600V may be necessary. To do this during normal operation, continuously hold the **AUDIO** button more than 5 seconds to activate the recording output calibrate sequence. The user can select the calibration sequence with Option Switch 3.

> **NOTE:** *The calibration signals are sent via the SpO_2 and pulse rate lines, not the serial output line.*

- *Standard Calibration:*
  The value sent for the SpO_2 will alternate from 0% (for 5 seconds) to 100% (for 6 seconds) to 50% (for 5 seconds) and then repeat. The value sent for the pulse rate will alternate from 0 BPM to 125 BPM to 250 BPM and then repeat. To end calibration sequence, release the **AUDIO** button, and the 8600V will return to normal operation.

- *Alternate Calibration:*
  The value sent for the SpO_2 will step through at 5% intervals when actuated by the user by pressing the **AUDIO** button beginning at 0% through 100% and then repeat. The value sent for the pulse rate will remain at 60 BPM. To end calibration sequence, hold the **AUDIO** button for 5 seconds, and the 8600V will return to normal operation.

Memory Playback (8600MV Only)

To place the 8600MV in playback mode, hold the **AUDIO** button while turning on the unit and release within 2 seconds. Memory playback is automatically initiated. While data is being played back, the SpO$_2$ display will show the hour of data being played back, and the ♥ display will show the minutes as they count down. Data is output as last data in is first data out.

> **NOTE:** Memory playback does not clear the memory of the 8600V. Data may be played back multiple times if desired.

Real-Time Setup Mode

To setup the real-time settings, hold the **AUDIO** button for more than 2 seconds on power on. **Prn** will appear in the upper LED display, indicating print setup mode. The 8600V automatically advances to the clock setting mode. Pressing the **AUDIO** button increments the number in the lower LED display. It starts with the current value stored in memory for that particular parameter. When the correct value appears in the lower display, release the **AUDIO** button and wait for the 8600V to advance to the next parameter as listed in Table II. This process is continued until all parameters are set. The settings can be easily checked, since the first value displayed for each parameter represents the current setting. When the setting sequence has been completed, the 8600V exits the setup mode and begins normal operation.

> **NOTE:** Setting the month to "00" disables the clock function and helps conserve battery life.

> **NOTE:** Clock parameters are not stored until all 5 parameter settings have been entered and the 8600V has automatically exited the clock setting mode and returned to normal operation.

> **NOTE:** If the oximeter is turned off before allowing the return to normal operation, the parameters entered will not be saved.

Sequence	Appears in SpO₂ Display	Range of Values	
		From	**To**
Printer	**Prn**	00	15
Year	**Ꮞ**	00	99
Month	**ΠΠ**	00	12
Day	**ᗡ**	01	31
Hours	**Ⴙ**	00	23
Minutes	**ΠΠ**	00	59

Table II: Printer, Calendar, and Clock Parameters

- Printer Settings

  Prn will appear in the SpO$_2$ display, indicating print setup mode. This option is not available at this time. Release the AUDIO button and wait for approximately 3 seconds for the 8600V to automatically advance to the calendar settings.

  NOTE: *There are 16 settings available for future expansion of the printer settings. Setting for the printer for any one of these values will have no effect on the 8600V.*
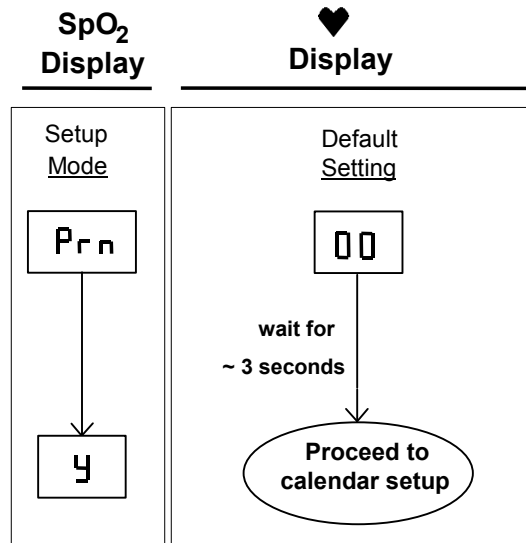
SpO$_2$ Display	♥ Display
Setup <u>Mode</u>	Default <u>Setting</u>
Prn	00
	wait for ~ 3 seconds
y	**Proceed to calendar setup**

Figure II: Flowchart for Setting Printer Mode

- Calendar Settings

    After the printer setting has been displayed in the setup mode, **५** will appear in the SpO₂ display, indicating calendar setup mode for the year. Press the **AUDIO** button momentarily to advance through the values. The year may be set to "00" through "99". After selecting the year, wait approximately 3 seconds for the display to show **Π Π**, indicating the setup mode for the month. The month may be set to "00" through "12" using the **AUDIO** button. After selecting the month, the display will show **⊔**, indicating the setup mode for the day of the month. The day may be set to "01" through "31". When the calendar setting sequence has been completed, the 8600V continues to the clock settings (refer to next section).
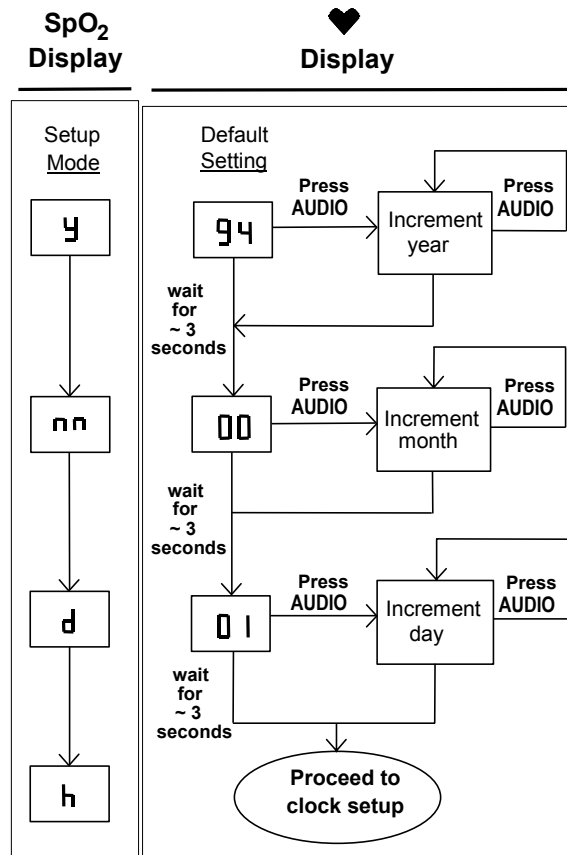

Figure III: Flowchart for Setting Calendar

- Clock Settings

  After the calendar settings have been determined in the real-time setup mode, ⊢ will appear in the SpO₂ display, indicating the hour.   The time is set in a 24-hour format. The hour may be set to "00" through "23". After selecting the hour, the display will show Π Π, indicating the minutes. The minutes may be set to "00" through "59". After selecting the minutes, the display will return to normal operation. Refer to Figure IV for a flowchart of setting the clock.

**SpO₂
Display**

**♥
Display**

Setup
Mode

Default
Setting

| h |

| 0 0 | **Press AUDIO** → Increment hour **Press AUDIO**

wait for ~3 seconds

| Π Π |

| 0 0 | **Press AUDIO** → Increment minute **Press AUDIO**

wait for ~3 seconds

| - |

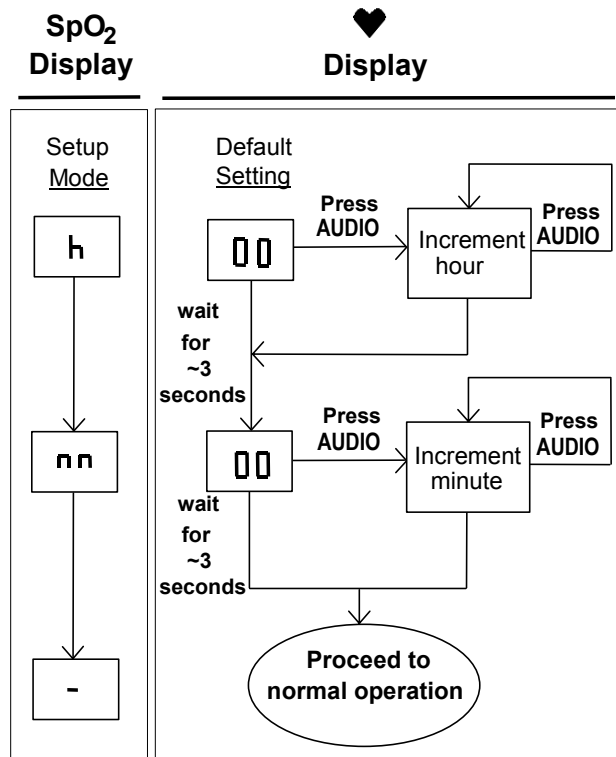(**Proceed to normal operation**)

Figure IV: Flowchart for Setting Clock

Patient Alarm Limits

Set the patient alarm condition switches located on the front of the 8600V to the attending veterinarian's recommendations. These values may be changed at any time and will take effect immediately.
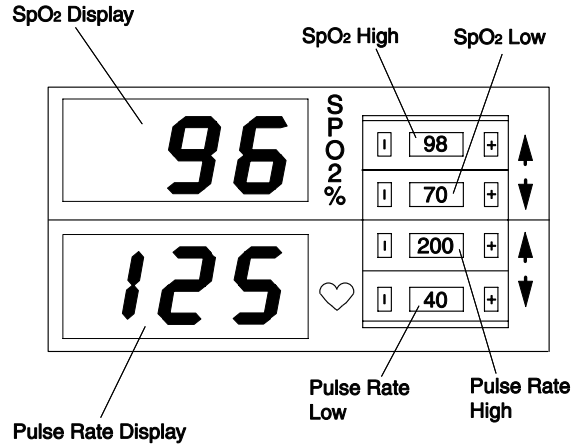

Figure V: Patient Alarm Display

Patient Alarm	Alarm Values
SpO$_2$ high	85, 90, 92, 94, 95, 96, 97, 98, 99, OFF
SpO$_2$ low	55, 60, 65, 70, 75, 80, 85, 86, 87, 88, 89, 90, 91, 92, 95, OFF
pulse rate high	60, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 425, OFF
pulse rate low	20, 25, 30, 40, 50, 60, 70, 80, 100, 120, 140, 160, 180, 200, 250, OFF

Table III: Patient Alarm Values

SpO$_2$ High Limit

The button labeled with the ⬘ next to the SpO$_2$% display sets the high SpO$_2$ alarm limit. The available values for the SpO$_2$ high alarm are given in Table III. An alarm condition exists if the SpO$_2$ level is at or above the chosen SpO$_2$ high limit level

- Press the ⊡ button to the left of the number to decrease value.
- Press the ⊞ button to the right of the number to increase value.

SpO$_2$ Low Limit

The button labeled with the ▽ next to the SpO$_2$% display sets the low SpO$_2$ alarm limit. The available values for the SpO$_2$ low alarm are given in Table III.

- Press the ⊡ button to the left of the number to decrease value.
- Press the ⊞ button to the right of the number to increase value.

Pulse Rate High Limit

The button labeled with the △ next to the ♥ display sets the high pulse rate alarm limit. The available values for the pulse rate high alarm are given in Table III.

- Press the ⊡ button to the left of the number to decrease value.
- Press the ⊞ button to the right of the number to increase value.

Pulse Rate Low Limit

The button labeled with the ▽ next to the ♥ display sets the low pulse rate alarm limit. The available values for the pulse rate low alarm are given in Table III.

- Press the ⊡ button to the left of the number to decrease value.
- Press the ⊞ button to the right of the number to increase value.

Pulse Volume

The 8600V may be set such that it will emit a short tone on each pulse detected. Turn the pulse volume control, marked with the ◁PULSE▷ symbol, until an audible pulse is heard with each beat. The tone will change pitch as the SpO$_2$ level changes. The pitch is lower in frequency with lower SpO$_2$ levels. A noticeably higher pitched tone is heard if the unit loses track of the pulse signal.

Alarm Volume

Adjust the alarm volume intensity by rotating the thumbwheel volume control on the front of the 8600V marked with the ◁ALARM▷ symbol. The OFF position is only effective when option switch 1 is in the up position. The option switches are located on the rear of the 8600V.

NOTE: *NONIN does not recommend disabling the audible alarm when monitoring in critical situations.*

To generate an alarm for test purposes, momentarily disconnect the patient cable assembly from the monitor. Press the latches and pull the connector out. This will generate a sensor alarm. The **SENSOR** indicator will illuminate. The audible alarm will sound provided the alarm volume control is not disabled, and option switch 1 is not in the up position, and the two-minute audible disable period is not active.

Option Switches

Option Switch 1
This switch controls the audible alarm OFF capabilities.

down: *Audible Alarm Cannot Be Disabled*
Prevents audible alarm from being permanently disabled by the user

up: *Audible Alarm May Be Disabled*
Allows the audible alarm to be permanently disabled by the user via the alarm volume dial turned to OFF

Option Switch 2
This switch controls the rate of averaging of the pulse rate and SpO_2 data.

down: *Fast Response Mode*
Pulse rate = 8-beat averaging;
SpO_2 = 4-beat exponential average

up: *Slow Response Mode*
Pulse rate = 16-beat averaging;
SpO_2 = 8-beat exponential average

Option Switch 3
Option switch 3 controls the analog output sequence for calibration of strip chart recorders.

NOTE: *This switch has no effect if you are not using the analog communications (strip chart recorders).*

down: *Standard Calibration Sequence*
Output analog values step from 0% to 100% to 50%

up: *Alternate Calibration Sequence*
Output analog values step from 0% to 100% in increments of 5%, and then to 127% for out-of-range

Option Switch 4
Option switch 4 controls the analog output format to pin 13 of the output connector.

down: *Analog Pulse Waveform:*
Output analog (0 - 1 VDC) waveform for the pulse rate

up: *Analog Pulse Rate:*
Output analog (0 - 1 VDC) value for pulse rate in the range of 0 to 250 pulses per minute

MEMORY CLEAR *Button (8600MV Only)*

The data within the internal memory is retained until it is cleared or overwritten by new data. To clear the internal memory the pulse oximeter is first placed in the "memory output mode" After the Memory Output Mode is entered, the memory is cleared by pressing and holding the **MEMORY CLEAR** button located on the rear of the monitor for a minimum of 5 seconds. This will cause the 8600MV to count quickly through all its memory locations, clearing each one.

NOTE: *Pressing the* **MEMORY CLEAR** *button during normal operation will not clear memory.*

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Visual Indicators

SpO₂ Display

The upper digital display is a 3-digit light emitting diode (LED) digital display that displays oxygen saturation percentage.

♥ (Pulse Rate) Display

The lower digital display is a 3-digit LED digital display that displays pulse rate in pulses per minute.

ʌʌ. (Perfusion) Indicator

The perfusion indicator (ʌʌ.) will flash once for each pulse while measuring oxygen saturation. The perfusion indicator changes color to indicate changes in the pulse waveform signal that may affect the SpO₂ data.

The perfusion indicator may blink one of three colors: green, yellow, or red.

Red indicates the pulse amplitude is too small. During red perfusion, SpO₂ and pulse rate values are not updated. After twenty seconds, the values are replaced with dashes indicating SpO₂ measurement is not possible.

Yellow indicates the pulse waveform amplitude is marginal or the pulse oximeter has detected artifact. Although SpO₂ data is acceptable, corrective measures should be considered to improve sensor placement, change sensor type, or reduce patient movement. After 90 seconds of yellow perfusion, the 8600V will go into sensor alarm mode.

Green indicates the pulse waveform signal is of good quality and SpO₂ data is accurate.

CAUTION!   The 8600V might interpret motion artifact as good perfusion. Limit motion as much as possible.

⨂ (Audible Alarm Inactive) Indicator

- The ⨂ indicator continuously illuminated indicates audible alarms are *permanently disabled*.
- The ⨂ indicator flashes at once a second when the audible alarms are *temporarily disabled*.

This indicator is a yellow ⨂ indicator that flashes when the audible alarm is temporarily disabled. The ⨂ indicator will illuminate continuously if the audible alarm has been permanently disabled via option switch 1 and the alarm volume OFF.

SENSOR Indicator

The **SENSOR** indicator continuously illuminated indicates there is a sensor alarm. This is caused by the system determining that the sensor is disconnected, damaged, or dislodged. When a sensor fault is found, the red **SENSOR** indicator illuminates and the audible alarm sounds continuously until the condition terminates.

If a sensor alarm condition persists for 10 seconds or longer the displays will show dashes (---). From the beginning of the sensor alarm condition up to the time that the displays go into the dash mode, the numerical values will freeze on the last valid values. The displays display new, valid data after three discernible pulses have been found.

CAUTION! A sensor alarm will result if 8600VI cable is connected incorrectly.

SELF TEST *Indicator*

The self test function is active whenever the unit is powered on. If a self test fault is found, the **SELF TEST** indicator illuminates and the audible alarm sounds continuously. This condition can only be cleared by turning the 8600V to STBY (**O**) and then back ON (**|**). This alarm cannot be shut off with the alarm volume control or by pressing the **AUDIO** button.

NOTE: *If this condition cannot be cleared, **do not** use the pulse oximeter. Contact NONIN Customer Support at (800) 356-8874 or (763) 553-9968.*

⊠ *(Low Battery) Indicator*

CAUTION! **Inaccurate SpO$_2$ and/or pulse rate measurement may result if the 8600V is operated in a low battery condition.**

The ⊠ indicator will illuminate in red if the battery voltage becomes low and the battery needs to be recharged. Fully charged batteries will typically power the 8600V for 30 hours. Charging depleted batteries will require 15 hours to fully recharge, but the pulse oximeter may be used if only partially recharged as long as the ⊠ indicator is not illuminated.

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

⊏⊐ *(Battery Charging) Indicator*

When the ⊏⊐ indicator is illuminated in green, the 8600V is connected to AC power and the battery is charging. To recharge a fully depleted battery, the 8600V must be connected to AC power for 15 hours.

If the ⊏⊐ indicator is not illuminated, the 8600V is operating from the battery (AC power is not connected).

Flashing Displays

♥ Display

If the animal's pulse rate is equal to or goes beyond the set limits, the ♥ display flashes at once per second until alarm condition concludes.

SpO$_2$ Display

If the animal's SpO$_2$ is equal to or goes beyond the set limits, the SpO$_2$ display flashes at once per second until alarm condition concludes.

♥ and SpO$_2$ Display

If both the SpO$_2$ and ♥ displays flash at once per second, both the pulse rate and SpO$_2$ values are equal to or go beyond the set limits.

Audible Indicators

CAUTION!   The audible alarm of the 8600V is for the convenience of the attendant near the animal. It is not intended to call an attendant from another room or from a distance. The user must determine the audible distance based on the operating environment.

Audible Alarm

- During normal operation, rotating the [ALARM] dial counter-clockwise until it clicks will turn the audible alarm OFF if option switch 1 is in the up position. If option switch 1 is in the down position, turning the audible alarm OFF will have no effect.
- During normal operation, pressing the **AUDIO** button disables the audible alarm for 2 minutes.
- Pressing the **AUDIO** button during the 2-minute disabled period immediately enables the audible alarm.
- The audible alarm sounds once per second for all patient alarms.
- The audible alarm sounds steadily for a sensor alarm.

The audible alarm is adjustable from OFF to 80 db(A).

Audible Pulse Tone

- During normal operation, rotating the [PULSE] dial counter-clockwise until it clicks will turn the audible pulse tone OFF.
- When enabled, the 8600V will sound a tick once for each heart beat.
- The tone varies in pitch with the SpO_2 level. As the SpO_2 level decreases, the pitch of the pulse tone decreases. If the 8600V loses the pulse, the audible pulse tone will beep at a much higher pitch.

The audible pulse tone volume may be varied from OFF to 70 db(A).

Communications

The 8600V may communicate in two forms: serial and analog communications. It may be connected to three different devices as given in Table IV. Real-time data may be output to all listed devices from a 8600V or 8600MV, and stored memory data may be output to all listed devices from a 8600MV.

Communication Link	Strip Chart Recorder	8586PI Printer Interface	PC (nVISION software)
Analog - Real-time - Memory Output	X		
Serial - Real-time - Memory Output		X	X

Table IV: Communications Links

Pin Number	Signal	Assignment
1	Ground	System Ground
2	+5 V	External +5 VDC Supply
3	Analog/Serial Control	Set high to send (high speed) serial data
4	Not Connected	Spare Input Line
5	Not Connected	Spare Output Line
6	Alarm	+5 V Activated with Audible Alarm
7	Pulse	+5 V Activated with each Pulse (corresponds to perfusion indicator)
8	Ground	System Ground
9	Serial Input	0 ± 5 V levels
10	Serial Output	0 ± 5 V levels
11	Not Connected	Not Connected
12	SpO_2	0 to +1 V levels corresponding to 0 to 100% SpO_2
13	Pulse <u>OR</u> Rate	Plethysmographic pulse waveform <u>OR</u> 0 to +1 V levels corresponding to 0 to 250 pulse per minute
14	Not Connected	Not Connected
15	+5 V	+5 VDC Internal Supply

Table V: Recording Output Interface Assignments

∿ indicator	flashing	solid	flickering
green	real-time data transfer	memory data transfer	printing memory data
yellow	waiting for data	data in memory	scrolling
red	real-time error	memory error	printing error

Table VI: Status Indicator During Data Transfer

Real-Time Data Output

Both the 8600V and 8600MV Pulse Oximeters provide real-time output capability to a custom printer via the 15-pin Sub-D connector labeled as "RECORDING OUTPUT" on the rear of the 8600V.

The information from the 8600V/8600MV 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 is output at a rate of once per second.

NOTE: *In real-time mode, the 9th data bit is always set to the mark condition. Therefore the real-time data may be read as 8 data bits, no parity.*

During data output, the $\bigwedge$ indicator displays the status of the data transfer as given in Table VI. The data printed out for real-time is in the following format:

HH:MM:SS   SPO2=XXX   HR=YYY

where "HH" represents the hour the real-time clock is set to, "MM" represents the minutes, "SS" represents the seconds, "XXX" represents the SpO_2 value, and "YYY" represents the heart rate. The SpO_2 and heart rate will be displayed as "---" if there is no data available for the data reading.

NOTE: *Pressing the* AUDIO *button during real-time printing will force a line to be printed (touch print).*

Memory Option (8600MV Only)

The memory option is identified by the "M" in the model number (i.e. 8600MV as opposed to the 8600V). The 8600MV Pulse Oximeter can collect and store up to eighteen hours of Patient SpO_2 and pulse rate information. This information may be output via the 15-pin sub-D connector labeled as "RECORDING OUTPUT" on the rear of the 8600V.

The solid-state memory in the 8600MV 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 8600MV is powered up, the current time/date information (if the clock is set properly) is stored in memory to allow quick differentiation of recording sessions. Patient SpO_2 and pulse rate are sampled and stored every four seconds. The stored resolution of the oxygen saturation is in 1% increments in the range of 0 to 100%. The stored pulse rate ranges from 18 to 300 BPM. The stored values have a resolution of 1 BPM from 18 to 200 and a resolution of 2 BPM from 201 to 300.

During the data printing, the last data recorded is the first data printed. During data output, the ᴧᴧ indicator displays the status of the data transfer.

Recording Sessions
Each time the 8600MV is turned on, data is automatically collected.

NOTE: *Only recording sessions longer than one minute are kept in memory.*

Memory Output Mode
To output the data stored in the memory of the 8600MV, start with the unit OFF and then:
1) Hold the **AUDIO** button while pressing the " | " switch.
2) Release the **AUDIO** button when **888 EEE** is displayed in the SpO_2 and ♥ LEDs.
3) Observe the hour and minute of the output data will be displayed in the SpO_2 and ♥ LEDs.
4) Data is automatically transferred from the memory.
5) When data is done being output, **dnE 000** is displayed.
6) Restart the 8600MV.

Data is transferred at a rate of 20 minutes of collected data per second. An 18-hour recording session (the maximum memory saved) is transferred in approximately 1 minute. After all the data is transferred, the 8600MV should be shut off prior to collecting new patient data. Outputting the memory does not clear any data from the memory. The patient information is held in memory until it is overwritten by new data unless you clear the memory by pressing the **MEMORY CLEAR** button for a minimum of 5 seconds while the 8600MV is in the Memory Output Mode.

NOTE: *If the memory has not been cleared, the 8600MV may be downloaded multiple times with the same data.*

Specifications

1. **Oxygen Saturation Range (SpO$_2$)** — 0 to 100%

2. **Pulse Rate Range** — 18 to 450 pulses per minute

3. **Displays**

Animal Indicators	Perfusion, SpO2 Low, SpO2 High Pulse Fast, Pulse Slow
Digital Displays	3-digit 7-segment LEDs
Equipment Indicators	Sensor, Self Test, Battery Low, Battery Charging, and Audible Alarm Disabled indicators

4. **Measurement Wavelengths**

Red	660 nanometers
Infrared	910 nanometers

5. **Accuracy** ∗

SpO$_2$ ($\pm$ 1 Standard Deviation)♦	70 - 100% $\pm$ 2 digits Below 70% is not specified for all sensors
Pulse Rate	$\pm$ 3% $\pm$ 1 digit

6. **Alarm Ranges**

High SpO$_2$ limit	85%, 90%, 92%, 94%, 95%, 96%, 97%, 98%, 99%, OFF
Low SpO$_2$ limit	55%, 60%, 65%, 70%, 75%, 80%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 95%, OFF
High pulse rate limit	60BPM, 75BPM, 100BPM, 125BPM, 150BPM, 175BPM, 200BPM, 225BPM, 250BPM, 275BPM, 300BPM, 325BPM, 350BPM, 375BPM, 425BPM, OFF
Low pulse rate limit	20BPM, 25BPM, 30BPM, 40BPM, 50BPM, 60BPM, 70BPM, 80BPM, 100BPM, 120BPM, 140BPM, 160BPM, 180BPM, 200BPM,250BPM, OFF

7. **Alarm Volume** — Adjustable to 85 dbA at 2 ft. (60 cm)

8. **Temperature**

Operating	0°C to +45 °C (+32°F to +113°F)
Non-operating	-20°C to +45 °C (-4°F to +113°F)

9. **Humidity**

Operating	10 to 90% non-condensing
Non-operating	10 to 95% non-condensing

10. **Battery Charger**

Model 8604A	120 VAC / 60 Hz
Model 8000A	230 VAC / 50 Hz

11. **Batteries** — 5-cell rechargeable Ni-Cad battery pack
30 hours minimum operation
15 hours to fully recharge

13. **Dimensions** — 5.8" wide x 2.7" high x 7.5" deep
14.7 cm x 6.9 cm x 19 cm

14. **Weight** — 2 lbs (0.75 kg)

♦ Standard Deviation is a statistical measure; up to 32% of the readings may fall outside these limits.

∗   Accuracy is specified for adult human hemoglobin measured at the fingertip. Other types of hemoglobin may affect accuracy.

Service and Support

CAUTION! 8600V Pulse Oximeters are sensitive and must be repaired by trained NONIN personnel only. Any evidence of opening the system, field repair by non-NONIN personnel, tampering, or any kind of misuse of the system will void the warranty entirely.

The solid state circuitry within the 8600V Pulse Oximeter requires no periodic maintenance or calibration. The internal battery pack will provide maintenance-free operation for up to 5 years and may be replaced by NONIN if necessary.

NONIN does not recommend field repair of the 8600V Pulse Oximeter. If opening the case is necessary, special precautions are required. To prevent damage, remove the four screws on the bottom of the 8600V using a screwdriver. Next, remove the four rubber feet. While gently pulling on the back of the cover, use a flat blade screwdriver to release the plastic catches. Failure to release the plastic catches when opening the case will damage the case.

The circuit board in the 8600V is a multi-layer board using traces 0.01" wide. Due to the very small trace size, extreme care must be used when replacing components to prevent permanent non-repairable damage to the circuit board. Most components are surface-mounted and require special hot air jet soldering and desoldering equipment. After any repairs are made, the pulse oximeter must be tested to ensure correct operation.

NOTE: *All repair work on the 8600V Pulse Oximeter should be done by trained NONIN personnel. For NONIN Customer Support contact:*

> Nonin Medical, Inc.
> 13700 1st Avenue North
> Plymouth, MN 55441-5443 USA
>
> (763) 553-9968
> (800) 356-8874 (USA and Canada only)
> FAX: (763) 553-7807

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 pulse oximeter using factory test fixtures.

Warranty

NONIN MEDICAL, INCORPORATED, (NONIN) warrants to the purchaser, for a period of three years from the date of delivery, each system exclusive of sensors, cables, and battery charger and for a period of six months from the date of delivery each sensor, cable and battery charger shall be free of defects in materials and workmanship such that each system properly used shall perform to specifications supplied within this manual. NONIN shall repair all systems 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 systems delivered to the purchaser which are 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. For any system sent to NONIN for warranty repair that is found to be within specification, the purchaser agrees to pay $100.00.

These systems are sensitive and must be repaired by knowledgeable and specially trained personnel only. Accordingly, 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.

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 the 8600V Pulse Oximeter:

Model	Description
Model	**Description**
	Accessories
8604A	Battery Charger 120 V / 60 Hz
8000A	Battery Charger 230 V / 50 Hz (European Turret)
8600CC	Carrying Case - Black
8600PMS	Pole Mount System (must be factory installed)
8600SB	Pole Mount Side Bracket (must be factory installed)
8600E-1	RS232 Cable
8600E-4	Analog Cable
8600PC	Printer Interface Cable
8600VI	Interface Cable - 9 feet/3 meters
8586PI	Printer Interface
	Sensors
2000SL	Lingual Clip
2000SA	Small Animal Flex Sensor
2000T	Transflectance Sensor
8000FC-20	Large Fiber Optic Sensor-20 feet/6 meters (For MRI use)
8000FC-30	Large Fiber Optic Sensor-30 feet/9 meters (For MRI use)
8000FI-20	Small Fiber Optic Sensor-20 feet/6 meters (For MRI use)
8000FI-30	Small Fiber Optic Sensor-30 feet/9 meters (For MRI use)

For more information about NONIN parts and accessories, contact your local distributor. If you do not have your local distributor information, call NONIN at **(800) 356-8874** or **(763) 553-9968,** and ask for your local distributor's name and phone number.

Troubleshooting Guide

Problem	Possible Cause	Possible Solution
Numeric displays are blinking once per second	SpO_2 or pulse rate alarm condition exists	*Examine the patient:* animal may need medical attention
Displayed pulse rate does not correlate to pulse rate displayed on ECG monitor	Excessive motion at sensor site may be prohibiting the 8600V from acquiring a consistent pulse signal	Eliminate or reduce cause of motion artifact *or* reposition sensor to new sensor site where motion is not present
	Animal may have an arrhythmia resulting in some heart beats that do not yield a perfusion signal at sensor sight	*Examine the animal:* condition may persist even though both monitors are functioning properly if animal's arrhythmia persists
	Non-NONIN sensor is being used	Replace sensor with a NONIN sensor
	ECG monitor may not be functioning properly	*Examine the animal:* replace ECG monitor *or* refer to operator's manual for ECG monitor
Erratic ♥ display and/or yellow perfusion indicator during concurrent use of electrosurgical equipment or ultrasonic dental scalers	ESU or ultrasonic dental scaler may be interfering with oximeter performance	*Examine the animal:* move oximeter, cables, and sensor as far away from ESU or ultrasonic dental scaler as possible *or* refer to the ESU operator's manual
Perfusion is blinking yellow with each pulse	Perfusion signal at sensor site is marginal	*Examine the animal:* reposition sensor *or* select alternate sensor site
Perfusion indicator is blinking red and SpO_2 and ♥ displays show dashes	Inadequate perfusion signal at sensor site Excessive motion at sensor site may be prohibiting 8600V from acquiring a consistent pulse signal	*Examine the animal:* reposition sensor *or* select alternate sensor site Eliminate or reduce cause of motion artifact or reposition sensor to sensor site where motion is not present
Segments of SpO_2 or ♥ display are missing	Defective LED displays	Displayed values may not be reliable; discontinue use of 8600V
Unable to obtain green perfusion	Low animal pulse strength	Reposition sensor on animal
	Sensor site poorly perfused	
	Sensor not correctly positioned	
	Sensor attached too tightly or tape or other items are restricting perfusion at sensor site	Reapply sensor, select alternate sensor site, or remove restrictive material from sensor site
	Circulation reduced due to excess pressure between the sensor and a hard surface.	Allow applied sensor to rest comfortably on a soft surface
	Excessive ambient light	Reduce ambient light
	Excessive animal motion	Reduce animal motion
	Interference from: • arterial catheter • blood pressure cuff • electrosurgical procedure • infusion line	Reduce or eliminate interference
Alarm going continuously but SpO_2 and pulse rate are within alarm limits	Internal circuitry watchdog failed	Reset 8600V by turning the unit OFF, wait a few seconds, and turn the unit ON

If any of these solutions do not correct the problem with your Model 8600V, please contact NONIN Customer Support at (800) 356-8874 (USA and Canada) or (763) 553-9968.