COVIDIEN

Service Manual

Nellcor™

Portable SpO_2 Patient Monitoring System

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1 Introduction

1.1 Overview

This manual contains information for servicing the Nellcor™ portable SpO_2 patient monitoring system.

This manual applies to the following product:

REF PM10N

Note:
Before use, carefully read this manual, the *Operator's Manual*, accessory Instructions for Use, and all precautionary information and specifications.

Reference the *Operator's Manual* for the following information:

- Intended Use statement
- Operations-related warnings and cautions
- Overviews of the display and operating buttons
- Descriptions of product and packaging symbols
- Installation and operation instructions
- Alarms management
- Preventive maintenance
- Performance considerations
- Accessories
- Theory of operations
- Product specifications
- Clinical studies

1.2 Safety Information

This section contains important safety information related to general use of the Nellcor™ portable SpO_2 patient monitoring system. Other important safety information appears throughout the manual. The Nellcor™ portable SpO_2 patient monitoring system is referred to as the "monitoring system" throughout this manual.

1.2.1 Safety Symbols

Table 1-1. Safety Symbol Definitions

Symbol	Definition
	**WARNING** **Alerts users to potential serious outcomes (death, injury, or adverse events) to the patient, user, or environment.**
	**Caution** **Identifies conditions or practices that could result in damage to the equipment or other property**.
	**Note** Provides additional guidelines or information.

1.2.2 Explosion, Shock, and Toxicity Hazards

WARNING:
Explosion hazard — Do not use the monitoring system in the presence of flammable anesthetics.

WARNING:
Shock hazard—Do not pour or spill liquids onto the monitoring system.

WARNING:
Shock hazard—Firmly close the battery cover to prevent moisture from entering the monitoring system.

WARNING:
The LCD panel (display) contains toxic chemicals. Do not touch broken LCD panels. Physical contact with a broken LCD panel can result in transmission or ingestion of toxic substances.

1.2.3 Service Procedures

WARNING:
To avoid possible injury, do not attempt to service the monitoring system if there are any signs of burning or smoking coming from the monitoring system.

WARNING:
Before attempting to service the monitoring system, disconnect it from the patient to avoid possible injury to the patient.

WARNING:
Before attempting to disassemble the monitoring system, remove the batteries to prevent possible injury.

WARNING:
Ensure that conductive portions of the electrodes, leads, and cable do not come into contact with any other conductive parts.

WARNING:
High voltage is generated by the LCD backlight driver. Exercise caution when operating the monitoring system with covers open.

WARNING:
Extreme care must be taken in modifying default or other settings to ensure they are appropriate to the intended use.

WARNING:
Make sure to complete all performance tests in *Chapter 4, Modification and Testing* before placing the monitoring system into operation after repair or maintenance. Failure to perform all tests could result in erroneous monitoring system readings.

WARNING:
Any connections between this monitoring system and other devices must comply with applicable medical systems safety standards such as IEC 60601-1. Failure to do so could result in unsafe leakage current and grounding conditions.

WARNING:
To ensure accurate performance and prevent device failure, do not expose the monitoring system to extreme moisture, such as direct exposure to rain. Such exposure may cause inaccurate performance or device failure. Reference the *Operator's Manual* for fluid ingress specifications.

1.2.4 Monitoring System Operation and Service

WARNING:
Inspect the monitoring system and all accessories before use to ensure there are no signs of physical damage or improper function. Do not use if damaged.

WARNING:
To ensure accurate performance and prevent device failure, do not expose the monitoring system to extreme moisture, such as direct exposure to rain. Such exposure may cause inaccurate performance or device failure. Do not immerse in water, solvents, or cleaning solutions, since the monitoring system and pulse oximetry sensors and connectors are not waterproof.

WARNING:
Do not sterilize the monitoring system by irradiation, steam, or ethylene oxide.

WARNING:
The monitoring system should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, observe the monitoring system to verify normal operation in the desired configuration.

WARNING:
The only user-serviceable parts inside the monitoring system are the four AA batteries. While users can open the battery cover to change the batteries, only qualified service personnel should remove the cover or access internal components for any other reason. Users should not modify any components of the monitoring system.

WARNING:
Do not spray, pour, or spill any liquid on the monitoring system, its accessories, connectors, switches, or openings in the casing, since this may cause damage to the monitoring system. Never place fluids on the monitoring system. If fluid spills on the monitoring system, remove batteries, wipe all components dry immediately, and have the monitoring system serviced to ensure no hazard exists.

WARNING:
Do not damage the batteries by applying pressure. Do not throw, hit, drop, or impact the batteries.

WARNING:
Keep the monitoring system and batteries out of the reach of children.

Caution:
The monitoring system may not operate properly if it is operated or stored at conditions outside the ranges stated in this manual, or if it is subjected to excessive shock or dropping.

1.2.5 Patient Monitoring and Safety

WARNING:
Always disconnect and remove the monitoring system and sensors during magnetic resonance imaging (MRI) scanning. Attempting to use the monitoring system during an MRI procedure could cause burns or adversely affect the MRI image or the monitoring system's accuracy.

WARNING:
Keep patients under close surveillance when monitoring. It is possible, although unlikely, that radiated electromagnetic signals from sources external to the patient and the monitoring system can cause inaccurate measurement readings.

WARNING:
As with all medical equipment, carefully route patient cabling to reduce the possibility of patient entanglement or strangulation.

WARNING:
Do not lift or carry the monitoring system by the pulse oximetry sensor or pulse oximetry interface cable. The cable may disconnect and cause the monitoring system to drop on a patient or cause damage to monitoring system surfaces.

1.2.6 Monitoring System Readings

WARNING:
The monitoring system may remain attached to the patient during defibrillation or during use of an electrosurgical unit; however, the monitoring system is not defibrillator-proof, and readings may be inaccurate during defibrillation and shortly thereafter.

WARNING:
Check the patient's vital signs by alternate means should there be any doubt about the accuracy of any measurement. Request a qualified service technician confirm the monitoring system is functioning correctly.

WARNING:
For best product performance and measurement accuracy, use only accessories supplied or recommended by Covidien. Use accessories according to their respective *Instructions for Use*.

1.2.7 Sensors, Cables, and Other Accessories

WARNING:
Before use, carefully read the pulse oximetry sensor *Instructions for Use*, including all warnings, cautions, and instructions.

WARNING:
Use only the Covidien-approved pulse oximetry sensors, interface cables, and accessories. Use of other sensors, cables, and accessories can result in inaccurate readings and increased monitoring system emissions.

WARNING:
Do not use any other cables to extend the length of the Covidien-approved interface cable. Increasing the length will degrade signal quality and may lead to inaccurate measurements.

WARNING:
To prevent damage, avoid undue bending of the sensor cable.

WARNING:
The sensor disconnect error message and associated alarm indicate the pulse oximetry sensor is either disconnected or has faulty wiring. Check the connection and, if necessary, replace the sensor, the pulse oximetry cable, or both.

1.2.8 Electromagnetic Interference

WARNING:
Any radio frequency transmitting equipment or other nearby sources of electrical noise may result in disruption of the monitoring system.

WARNING:
The monitoring system is designed for use in environments in which the signal can be obscured by electromagnetic interference. During such interference, measurements may seem inappropriate or the monitoring system may not seem to operate correctly.

WARNING:
Large equipment using a switching relay for its power on/off may affect monitoring system operation. Do not operate the monitoring system in such environments.

Caution:
This device has been tested and found to comply with the limits for medical devices related to IEC 60601-1-2: 2007 and IEC 60601-1-2:2014. These limits are designed to provide reasonable protection against harmful interference in a typical medical installation.

Caution:
This monitoring system generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to other devices in the vicinity. If interference is suspected, move pulse oximetry cables away from the susceptible device.

Caution:
Be aware of possible interference from sources of electromagnetic interference, such as cellular phones, radio transmitters, motors, telephones, lamps, electrosurgical units, defibrillators, and other medical devices. If pulse oximetry readings are not as expected for the patient's condition, remove the sources of possible interference.

1.2.9 Connections with Other Equipment

Caution:
Accessory equipment connected to the monitoring system's data interface must be certified according to IEC 60950-1 for data-processing equipment. All combinations of equipment must be in compliance with IEC 60601-1 Requirements for Medical Electrical Systems. Anyone who connects additional equipment to the signal input or signal output port configures a medical system and is therefore responsible for ensuring the system complies with the requirements of IEC 60601-1, IEC 60601-1-2:2007, and IEC 60601-1-2:2014.

Caution:
When connecting the monitoring system to any instrument, verify proper operation before clinical use.

Caution:
Anyone who connects a PC to the data output port configures a medical system and is therefore responsible for ensuring that the system complies with the requirements of IEC 60601-1-1 and the electromagnetic compatibility IEC 60601-1-2.

1.2.10 Monitoring System Storage, Transport, and Disposal

Caution:
Remove the batteries from the monitoring system before placing it in storage or when not using it for a long period.

Caution:
Do not short-circuit the batteries, as they may generate heat. To avoid short-circuiting, do not let the batteries come in contact with metal objects at any time, especially during transport.

Caution:
Follow local government ordinances and recycling instructions regarding disposal or recycling of the monitoring system and its components, including batteries and accessories.

1.3 Obtaining Technical Assistance

1.3.1 Technical Services

For technical information and assistance, contact Covidien or a local Covidien representative.

Covidien Technical Services: Patient Monitoring

15 Hampshire Street

Mansfield, MA 02048 USA

1.800.635.5267, 1.925.463.4635,
or contact a local Covidien representative

www.covidien.com

When calling Covidien or a local Covidien representative, have the monitoring system serial number available. The serial number label is located on the bottom of the monitoring system. Provide the firmware version number displayed during the power-on self-test (POST).

1.3.2 Related Documents

Nellcor™ Portable SpO_2 Patient Monitoring System Operator's Manual — Provides basic information for operating the monitoring system and troubleshooting errors or malfunctions.

Nellcor™ Pulse Oximetry Sensor Instructions for Use — Guides sensor selection and usage. Before attaching any of the various Covidien-approved pulse oximetry sensors to the monitoring system, refer to the individual *Instructions for Use*.

Nellcor™ Oxygen Saturation Accuracy Specification Grid — Provides sensor-specific guidance related to desired SpO_2 saturation accuracy measurements. Available online with the product manuals for the monitoring system at www.covidien.com.

1.4 Warranty Information

The information contained in this document is subject to change without notice. Covidien makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Covidien shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

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2 Service Menu Options

2.1 Overview

This chapter describes Service Menu settings for the Nellcor™ portable SpO_2 patient monitoring system. A password is required to access the Service Menu. Contact Technical Services (reference *Technical Services*, page 1-8) for the default password.

2.2 Safety Reminders

WARNING:
For best product performance and measurement accuracy, use only accessories supplied or recommended by Covidien. Use accessories according to their respective *Instructions for Use*.

WARNING:
The sensor disconnect error message and associated alarm indicate the pulse oximetry sensor is either disconnected or has faulty wiring. Check the connection and, if necessary, replace the sensor, the pulse oximetry cable, or both.

WARNING:
Do not use damaged pulse oximetry sensors. Do not use with exposed optical components. Do not immerse completely in water, solvents, or cleaning solutions, since pulse oximetry sensors and connectors are not waterproof. Do not sterilize by irradiation, steam or ethylene oxide. Refer to the cleaning instructions in the *Instructions for Use* for reusable sensors.

Caution:
Do not attach any cable intended for computer use to the sensor port connector.

2.3 Service Menu Overview

WARNING:
Only qualified service personnel should open the monitoring system housing, remove and replace parts, or make adjustments.

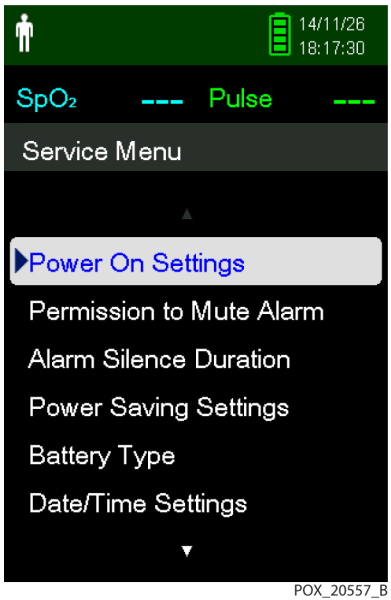
The monitoring system contains a Service Menu that is accessible only by password. Contact Technical Services (reference *Technical Services*, page 1-8) for the default passwords for all restricted menus and functions.

The monitoring system ships with the Service Menu factory default settings listed in *Table 2-1*. For a list of the factory default settings for other menus, reference the *Operator's Manual*.

Table 2-1. Service Menu Settings

Parameter	Ranges/selection	Factory default		
		Adult	Pediatric	Neonatal
Power On Settings	Factory Defaults, Institutional Defaults, Last Setting	Factory Defaults		
Permission to Mute Alarm	No, Yes	No		
Alarm Silence Duration	30, 60, 90, 120 seconds	120 seconds		
Power Saving Settings	Screen Saver Time: Never, 1 - 10 minutes	3 minutes		
	Screen Saver Brightness: 0% - 50% in 10% increments	20%		
	Auto Power Off Time: Never, 1 - 10 minutes	3 minutes		
Battery Type	Lithium, Alkaline	Lithium		
Date/Time Settings	Date Format: YY/MM/DD, DD/MM/YY, MM/DD/YY	YY/MM/DD		
Communication Settings	Serial Connectivity Settings: ASCII 19200, ASCII 115200, SPDout 19200, SPDout 115200	ASCII, 19200		
Alarm Priority Settings	Low, Medium, High: - Sensor Disconnect - Sensor Off - Sensor Failure	Low		
	Low, Medium, High: - SpO_2 High - Pulse Rate High	Medium		
	Medium, High: - SpO_2 Low - Pulse Rate Low	Medium		
Languages	Chinese, Czech, Danish, Dutch, English, Finnish, French, German, Greek, Hungarian, Italian, Japanese, Korean, Norwegian, Polish, Portuguese, Russian, Slovakian, Spanish, Swedish, Turkish	English		
Dynamic Password	Passwords can be changed for entry into Homecare Mode and Sleep Study Mode and back to Standard Mode	(Contact Technical Services)		
Enable PCSync Mode	On, Off	Off		

Figure 2-1. Service Menu



2.3.1 Power On Settings

Caution:
Last Settings should only be used in a service situation, not during normal operation.

Note:
Once changes are made to any settings, you must choose Last Settings or Institutional Defaults to have those settings saved when the monitoring system is powered off.

Factory Defaults — The settings for the monitoring system when shipped from the manufacturer. Choose this option to reset all values to factory defaults. (Default)

Institutional Defaults — The settings of the monitoring system for an individual institution or patient situation. Set all desired parameters, then go to the Service Menu and select Institutional Defaults. The monitoring system powers off once you exit the Service Menu. When you power on the monitoring system again, the institutional defaults you set will be active. When you switch between operating modes (for example, between Sleep Study Mode and Standard Mode), the institutional defaults are retained.

Last Settings — The settings of the monitoring system are saved just before power off.

2.3.2 Permission to Mute Alarm

No — User cannot disable the audible alarm for SpO_2 or pulse rate alarms. (Default)

Yes — User can disable the audible alarm for SpO_2 or pulse rate alarms.

Note:
The visual alarm (the yellow background behind the SpO_2 or pulse rate reading) is always enabled, even when the audible alarm is disabled.

2.3.3 Alarm Silence Duration

The amount of time the audible alarm remains silent after the Silence Alarm button is pressed. Options include 30, 60, 90, and 120 seconds (default).

2.3.4 Power Saving Settings

Provides options for prolonging battery life during operation:

Screen Saver Time — By default, the screen dims after 3 minutes if no button is pressed. This value can be changed to 1 - 10 minutes or Never. When the screen dims, pressing any button returns the screen to normal brightness.

Screen Saver Brightness — By default, when the screen saver option is in effect, the screen dims to 20% of full brightness after the specified time without a button press. This value can be changed to 0 - 50% in 10% increments. When the screen dims, pressing any button returns the screen to normal brightness.

Auto Power Off Time — By default, the monitoring system powers off after 3 minutes if no button is pressed. This value can be changed from 1 - 10 minutes or Never.

2.3.5 Battery Type

Provides power optimization when using different battery types:

- Lithium (default)
- Alkaline

2.3.6 Date/Time Settings

Provides options for the date format: YY/MM/DD (default), MM/DD/YY, or DD/MM/YY. Allows manual setting of the year, month, and day, and the hour, minute, and second.

2.3.7 Communication Settings

The serial connectivity settings to be used when trend data is transferred from the monitoring system to a PC using a USB cable. Options include:

- ASCII, 19200 baud (default)
- ASCII, 115200 baud

- SPDout, 19200 baud
- SPDout, 115200 baud

2.3.8 Alarm Priority Settings

Allows the setting of alarm priorities for Sensor Disconnect, Sensor Off, Sensor Failure, SpO_2, and Pulse Rate alarms. Reference *Table 2-1 on page 2-2*.

2.3.9 Languages

Displays most menu items in the chosen language (reference *Table 2-1 on page 2-2* for the complete list of languages). For some languages, certain menu items are not translated and always display in English.

2.3.10 Dynamic Password

Allows changes to the passwords for switching between the following operating modes:

- Homecare to Standard Mode
- Standard to Homecare Mode
- Sleep Study to Standard Mode
- Standard to Sleep Study Mode

Contact Technical Services (reference *Technical Services*, page 1-8) for the default passwords. Reference *Dynamic Passwords*, page 4-7 for instructions for changing these passwords.

2.3.11 Enable PCSync Mode

Enables use of the PCSync™* utility for testing the monitoring system and performing firmware upgrades. Choices are On or Off (default).

2.3.12 About Monitor

Model Name — PM10N

System Software Version — The version of the software (firmware) loaded on the monitoring system

SpO_2 Module Version — The software version of the SpO_2 circuit board installed in the monitoring system

2.3.13 Covidien Service

For Covidien personnel only.

3 Data Management

3.1 Overview

This chapter contains information for accessing, transmitting, and downloading patient monitoring data and history. This chapter also contains instructions for upgrading firmware for the Nellcor™ portable SpO_2 patient monitoring system. The monitoring system supports the following types of data viewing and transmission:

- **Access stored monitoring history —** Monitoring history (trend data) can be viewed anytime it is stored in the monitoring system. Reference the *Operator's Manual*.
- **Download stored monitoring history —** Monitoring history can be downloaded to a PC using the HyperTerminal™* program or other data transmission and analysis tools.
- **Upgrade the monitoring system's firmware —** Occasionally, Covidien will provide upgrades to the firmware for the monitoring system, which must be loaded via the mini-USB port.

3.2 External Data Communication

WARNING:
Any connections between this monitoring system and other devices must comply with applicable medical systems safety standards such as IEC 60601-1 and applicable collaterals. Failure to do so may result in unsafe leakage current and grounding conditions.

Caution:
Do not attach any cable intended for computer use to the sensor port connector.

Caution:
Connect the monitoring system to a medical grade PC that is on an isolated AC circuit.

3.2.1 Monitoring History Download

WARNING:
Replacing the coin cell battery for the main board resets the monitoring system's date and time settings. Integrity of existing patient data will be questionable. Reset the date and time after replacing this battery with a known good battery.

Caution:
Anyone who connects a PC to the data output port configures a medical system and is therefore responsible for ensuring that the system complies with the requirements of IEC 60601-1-1 and the electromagnetic compatibility IEC 60601-1-2.

Caution:
Signal artifacts, secondary to a variety of external factors, may compromise the presence or accuracy of the displayed values.

Caution:
If the monitoring system does not contain its own isolation barrier, connect it to a medical grade PC that is on an isolated AC circuit.

The monitoring system presents monitoring history (trend data) in tabular format. The newest data values appear at the top.

To download monitoring history (trend data), connect by mini-USB port to a PC using the HyperTerminal™* program or other data transmission and analysis tools. Any PC connected to the data port must be certified according to IEC 60950. All combinations of equipment must be in compliance with IEC 60601-1-1 system requirements.

Note:
Users may choose to import patient monitoring history to a spreadsheet program. To do so, export monitoring history using the ASCII format option. Have a qualified service technician set this option prior to attempting a data download.

System Compatibility Prerequisites

- Windows™* operating system
- HyperTerminal™* program or equivalent data transmission and analysis software installed on the PC

Hardware

- Mini-USB data download cable
- CD or thumb drive, if USB driver required

Data transfer by USB port relies on existing communication software drivers for USB-based devices already on the computer, so should not require any modification of the drivers used by the USB interface. If, for some reason, the computer does not have the correct USB driver, use the device driver provided on the product CD or from Technical Services. Reference *COM Port USB Driver Alternatives*, page 3-6.

Note:
Any monitoring history download relies on either factory default settings or institutional default settings established by a qualified service technician prior to usage. This includes baud rate and communication protocol selection.

To download monitoring history using the HyperTerminal™* program

1. Configure the monitoring system's serial connectivity settings appropriately.
2. Connect the monitoring system's mini-USB port to the computer.

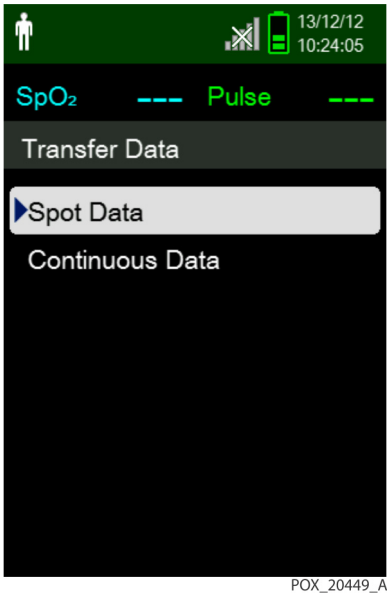
Figure 3-1. Mini-USB Port

3. Execute the HyperTerminal™* program.

Note:
If this is the first time the HyperTerminal™* program launches, it will prompt the user to set it as the default Telnet program. Depending on institutional requirements, choose Yes or No.

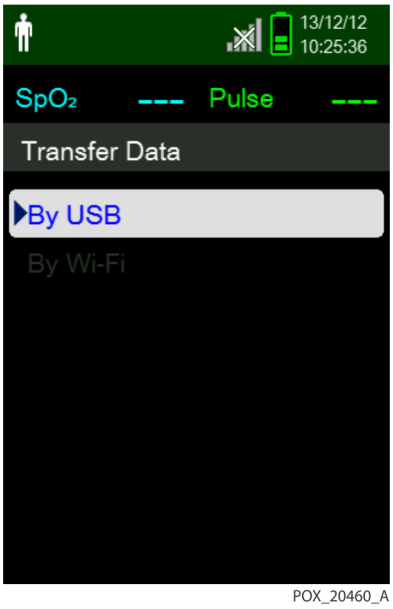
4. Set appropriate port setting values for the HyperTerminal™* program:
    a. Set the baud rate (bits per second) to match the monitoring system's baud rate.
    b. Ensure the data bit is set to 8.
    c. Ensure the parity bit is set to none.
    d. Ensure the stop bit is set to 1.
    e. Ensure the flow control is set to off.
5. From the monitoring system's Transfer Data menu, select Spot Data or Continuous Data.

Figure 3-2. Transfer Data Type



6. Select By USB.

Figure 3-3. Transfer Data by USB



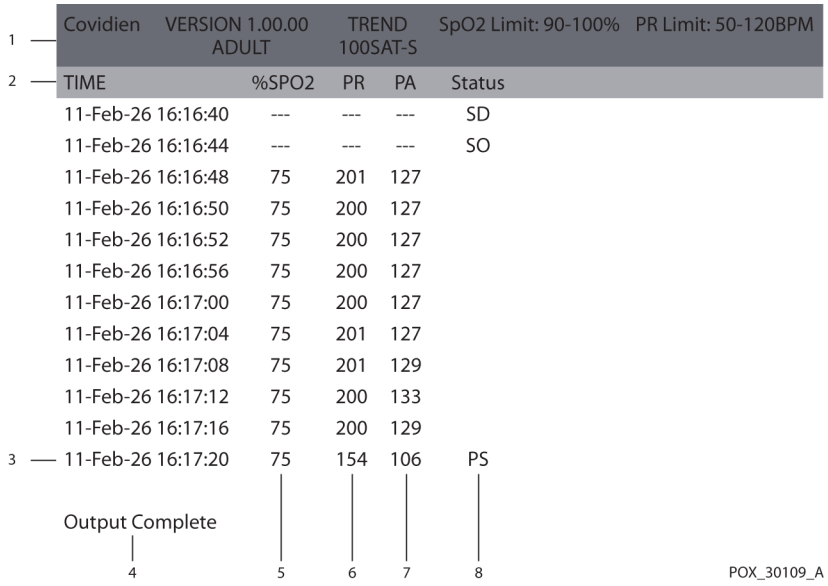
The data is transferred, and a progress bar is displayed. If desired, select Cancel to abort the transmission.

The Output Complete message is displayed when the transmission is complete.

To interpret downloaded monitoring history

1. Examine monitoring history on the HyperTerminal™* program screen, in a spreadsheet, or on a printout from the personal computer.

Figure 3-4. Sample Monitoring History Printout



1	Product column headings	Data source, firmware version, and system settings
2	Patient data column headings	Lists appropriate time and data headings
3	Time column	Real-time clock date and time stamp
4	Output Complete	Message indicating completion of monitoring history download
5	%SpO_2	Current saturation value
6	PR	Current pulse rate
7	PA	Current pulse ampltitude
8	Status	Operating status of the monitoring system

2. Ensure patient data settings coincide with expected settings. This would include the version of firmware and its CRC code, which should be all zeros; alarm limit settings; patient mode; and SatSeconds™ setting.

3. Scan the time, SpO_2, or PR column until reaching the events of interest.

4. Reference *Table 3-1 on page 3-6* for descriptions of the operating status codes.

Table 3-1. Monitoring Status Codes

Status code	Description
LM	Loss of pulse, patient motion
LP	Loss of pulse
CB	Critically low battery
LB	Low battery
SO	Sensor off
SD	Sensor disconnect
AO	Alarm off
AS	Alarm silenced
MO	Signal interference, patient motion
PS	Pulse search

COM Port USB Driver Alternatives

- Load the appropriate driver from the product CD into the connected computer.
- Contact Technical Services or a local Covidien representative.

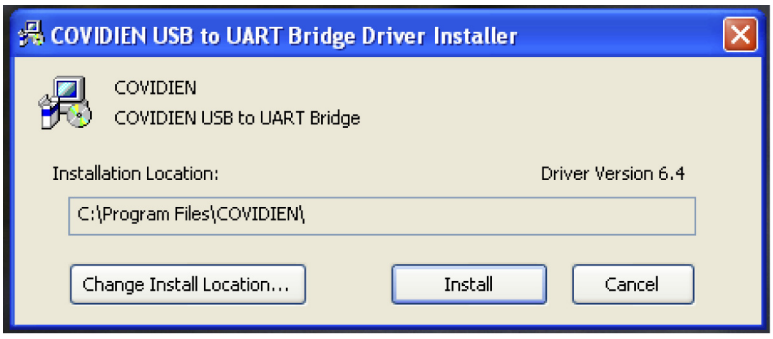
To install a USB driver from the compact disc

1. Insert the Nellcor™ portable SpO_2 patient monitoring system compact disc (CD) into the designated personal computer (PC).
2. Copy the COVIDIEN USB to UART Bridge Driver zip file to the PC, installing it in the desired program folder.
3. Right-click on the zipped folder.
4. Select Extract All.
5. Open the extracted folder.
6. Launch the Driver Installer executable file.

Note:
To change the location of the driver, select the desired mapping by clicking Change Install Location.

7. Click Install.

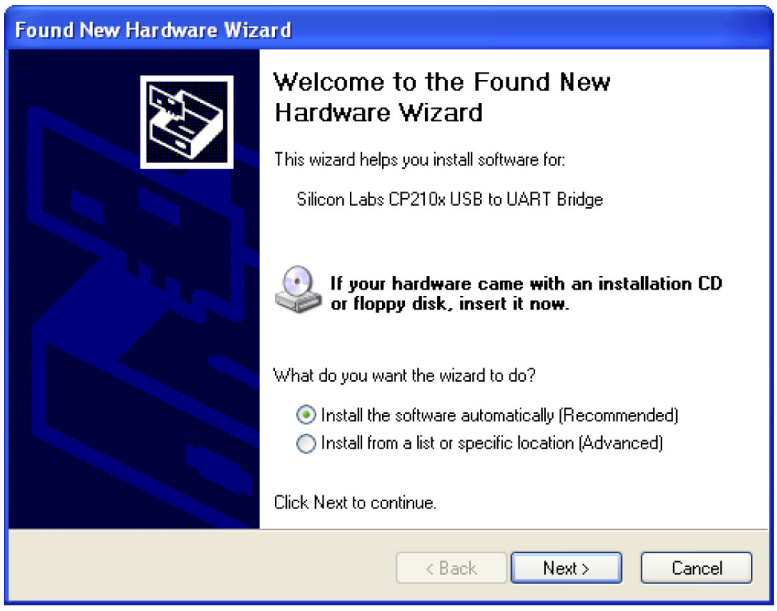
Figure 3-5. Sample Bridge Driver Installer Window



POX_30122_A

8. Reboot the PC for changes to take effect.
9. Connect the monitoring system to the PC, firmly engaging the USB end to the PC and the mini-USB to the monitoring system.
10. Allow the PC to sense the new hardware and load the installer, which guides users through the entire setup process. Do not click Cancel.

Figure 3-6. Sample New Hardware Wizard Screen



POX_30124_A

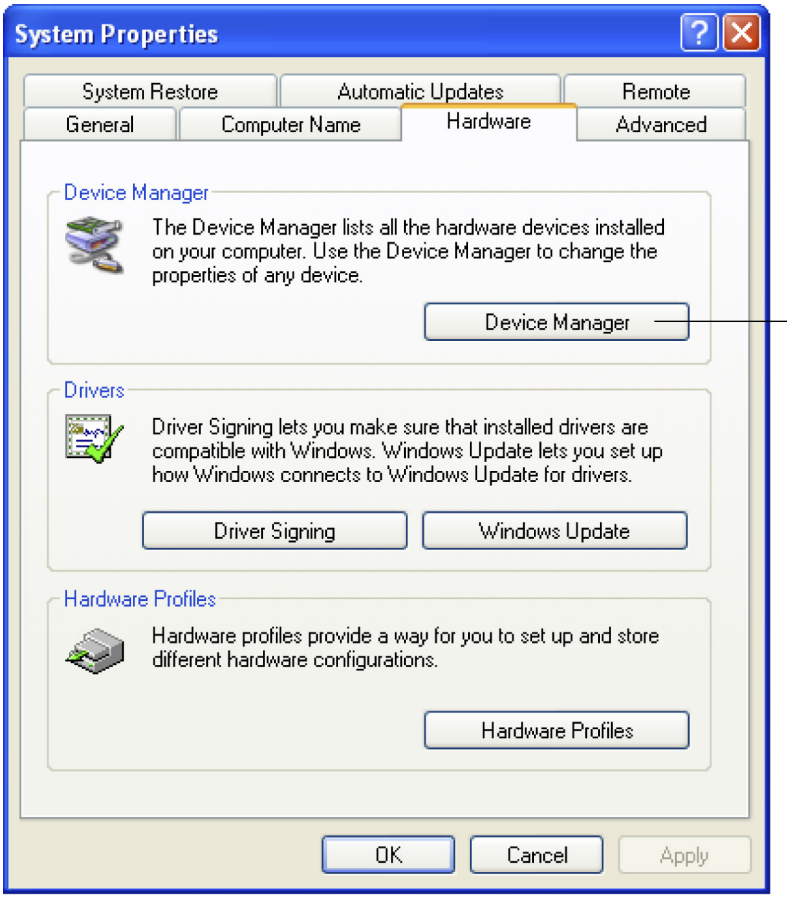
11. At the prompt from the installer, click Next to copy the driver to the PC.
12. When the installer provides the end-user license agreement, read it carefully, then click the button for accepting the terms of the license.
13. Click Next to formally accept the agreement.

14. Review the Destination Folder mapping. To change the destination, click Browse and select the desired mapping.
15. Click Next to formally accept the Destination Folder mapping.
16. Click Install in the resulting driver installer window. Do not click Cancel.

Note:
If a Windows™* security window pops up, select the option to install the driver anyway.

17. Click OK to complete the installation in the resulting Success window.
18. Reboot the PC for changes to take effect.
19. From the Start menu, click the Settings menu option and select the Control Panel option.
20. Select the System option to open the System Properties window.
21. Click the Hardware tab, then the Device Manager button.

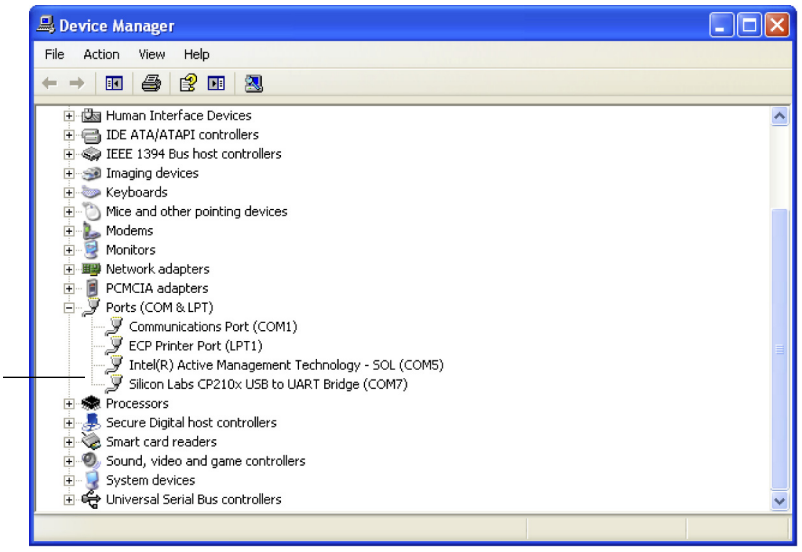
Figure 3-7. Device Manager Button, Hardware Tab



POX_30119_A

22. Select the Ports option from the resulting list.

Figure 3-8. Sample Hardware List in Device Manager Window

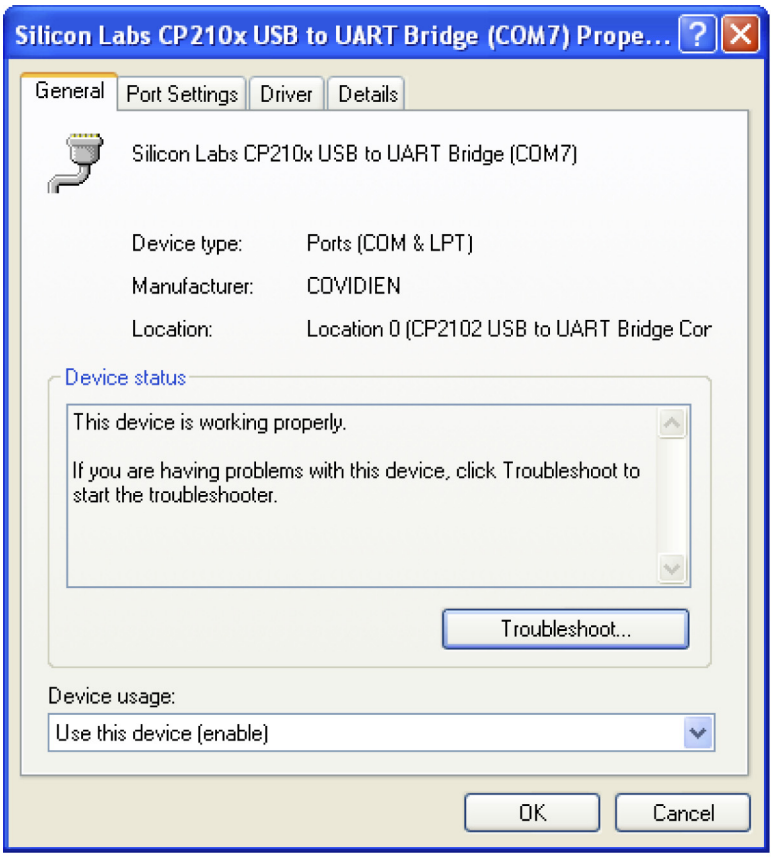


POX_30126_A

23. Double click the Silicon Labs CP210x USB to UART Bridge option.

Note:
The listed COM port should match the HyperTerminal™* program COM port designation. Reference *To download monitoring history using the HyperTerminal™* program*, page 3-3.

Figure 3-9. Sample Initial USB to UART Bridge Properties Window

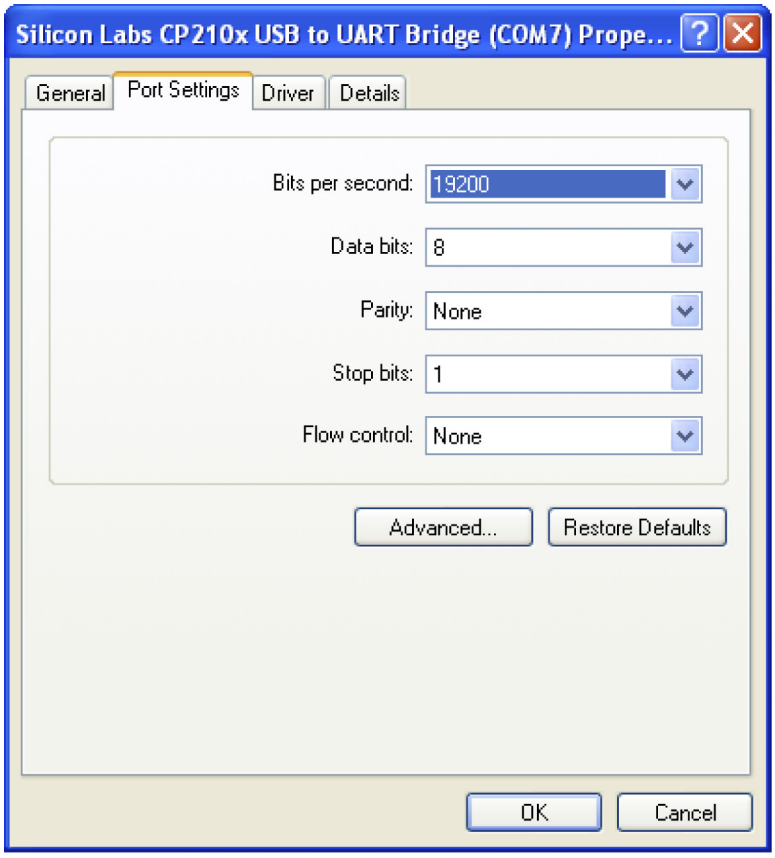


POX_30125_A

24. Click the Port Settings tab.

25. Set the bits per second to one of the following baud rates: 19200 or 115200. The factory default is 19200 bps.

Figure 3-10. Baud Rate List, Port Settings Tab



POX_30127_A

26. Click OK to complete the process.

27. Reference *To download monitoring history using the HyperTerminal™* program*, page 3-3 to download monitoring history. Or, use a different data transmission and analysis tool.

3.3 Firmware Upgrade

Caution:
To help prevent the loss of power during the upgrade, make sure to use new batteries.

Caution:
Do not press buttons other than those specified in the following instructions. The firmware upgrade can be interrupted or canceled by pressing any button.

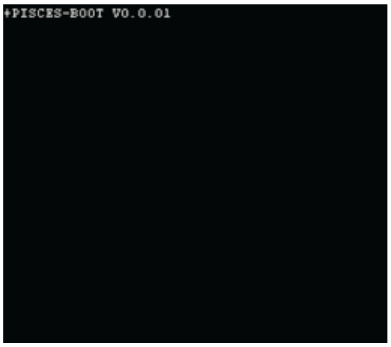
Caution:
When the firmware version (.bin) is not matched with the correct version of the resource file (.res), the monitoring system may not operate properly.

This section describes how to upgrade the firmware for the monitoring system. Firmware updates occur periodically, and the monitoring system should be kept up to date to ensure proper operation. Reference *System Error Codes*, page 5-6 if errors occur during firmware upgrade.

To upgrade firmware

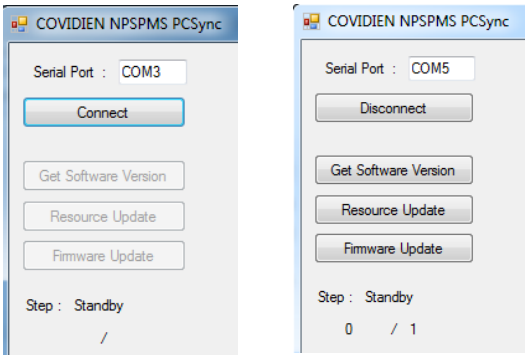
1. Install and run the PCSync utility on the PC to be used for the upgrade.
2. Turn off the monitoring system.
3. Connect a mini-USB cable from the monitoring system to the PC.
4. On the monitoring system, press the Power On/Off button and Down button together.
5. The monitoring system powers on in firmware update mode, as shown in *Figure 3-11*.

Figure 3-11. Firmware Upgrade Mode



6. Start the PCSync™* utility.

Figure 3-12. Firmware Upgrade, PCSync™* Utility



7. Complete the connection between the monitoring system and the PCSync™* utility by using the PC's Device Manager to determine the serial port number for the USB to UART Bridge.

   Enter the port number in the Serial Port box at the top left of the dialog box, then click Connect.

   To verify the connection, click Get Software Version in the PCSync™* dialog box. A pop-up window containing the current version of the monitoring system firmware is displayed.

8. If the Resource file needs to be updated, click Resource Update and select the appropriate .res file.

   When the file is selected, the resource upgrade procedure begins automatically.

   Upon completion of the resource update, the Complete message is displayed in the PCSync utility.

   If the Resource file does not need to be updated, skip this step.

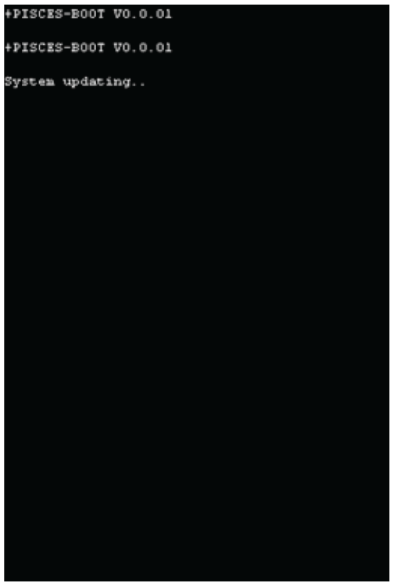
9. Click the Firmware Update button and select the appropriate .bin file.

   When the file is selected, the firmware update begins automatically.

   Upon completion of the firmware update, the Complete message is displayed in the PCSync utility.

   The screen shown in *Figure 3-13* is displayed as the monitoring system is updated. Then the monitoring system is automatically reset.

Figure 3-13. Firmware Upgrade Process



POX_20518_A

10. Verify the upgrade is complete by checking the POST screen and firmware version.

Figure 3-14. POST Screen and Firmware Version

POX_20522_A

Note:
The monitoring system's previous settings are not modified during the upgrade. Reference the *Operator's Manual* for power-on settings.

4 Modification and Testing

4.1 Overview

WARNING:
Only qualified service personnel should open the monitoring system, remove and replace parts, or make adjustments. If your medical facility does not have a qualified service technician, please contact Covidien Technical Services or your local Covidien representative.

This chapter provides information to trained service technicians on verifying Nellcor™ portable SpO_2 patient monitoring system performance following repairs or during preventive maintenance. When performing tests, follow these guidelines:

- All tests can be performed without removing the covers from the monitoring system.
- For many of the tests, the PCSync™* utility shown in *Figure 3-12 on page 3-12* provides an efficient way to change the monitoring system's settings.
- All tests must be performed as the last operation before the monitoring system is returned to the user.
- If the monitoring system fails to perform as specified in any test, repairs must be made to correct the problem before the monitoring system is returned to the user.

Note:
Many of the tests in this chapter require access to the monitoring system's Service Menu. Contact Covidien Technical Services for the pass code to this menu.

4.2 Required Equipment

Table 4-1. Required Test Equipment

Equipment	Description/use
SpO_2 sensor (durable)	DS-100A Durasensor™ adult finger clip sensor
SpO_2 extension cable	DEC-4
SpO_2 simulator	Nellcor™ model SRC-MAX
Stop watch	Manual or electronic, for alarm silenced and alarm reminder intervals

Note:
Contact Covidien Technical Services for pricing and ordering information of the required equipment. Reference *Technical Services*, page 1-8.

4.3 System Performance Tests

Caution:
If using the PCSync™* utility to change settings for the monitoring system, make sure all the settings on the PCSync™* screen are correct before clicking Send. Otherwise, unexpected settings will result.

4.3.1 Power-On Self-Test (POST)

To check the power-on self-test (POST)

1. With the monitoring system off, press and hold the Power On/Off button for approximately 1 second.

   While the monitoring system performs power-on self-test (POST), a progress bar appears at the bottom of the display.Verify that the following steps occur:

   a. The product name and software version number are displayed on the POST screen.

   b. When POST completes successfully, one pass tone sounds, and the monitoring system displays the main monitoring screen.

Figure 4-1. Power-On Self-Test Sequence

POX_20522_A

Note:
POST takes approximately 10 seconds to complete.

Note:
If an error occurs during POST, the monitoring system displays an error message. Reference *Chapter 5, Troubleshooting*.

4.3.2 Battery Status

To verify battery status

1. Insert the batteries into the monitoring system.
2. Press and hold the Power On/Off button for approximately 1 second.
3. Verify the monitoring system is turned on and operating normally.

   - Verify the Battery status icon on the display. The battery status icon displays the remaining battery capacity.
   - If the monitoring system is in a critically low battery condition, the high priority alarm occurs for about 5 minutes before the monitoring system shuts down automatically. Replace the batteries.
   - When the monitoring system is in a low battery condition, the remaining battery power is only enough for 15 minutes of operation. Replace the batteries.

4. Press and hold the Power On/Off button for approximately 1 second and verify that the monitoring system turns off.

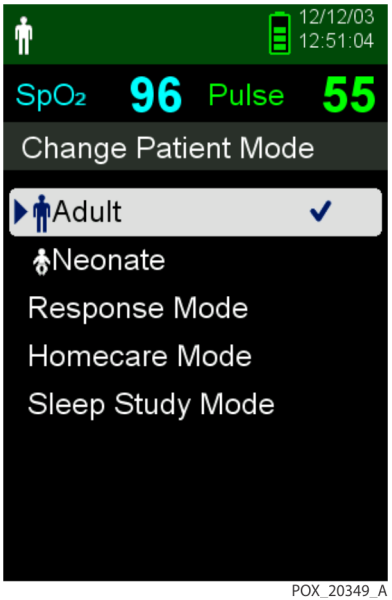
4.3.3 Patient Modes

To verify that patient modes can be selected

1. Select the Change Patient Mode menu.

   A check mark appears next to the selected patient mode.

Figure 4-2. Change Patient Mode Menu



2. Press the Down button to highlight each patient mode and press OK to verify that the correct patient mode icon appears.

   Pass codes are required to change to Homecare Mode, Sleep Study Mode, and back to Standard (Adult or Neonatal) Mode.

   Table 4-2 on page 4-5 lists the patient modes and their icons. The icon for the current patient mode setting appears in the upper left of the monitoring system's display.

Note:
To change to Homecare Mode or Sleep Study Mode requires a unique pass code for each mode. Contact Covidien Technical Services for these pass codes.

Table 4-2. Patient Modes

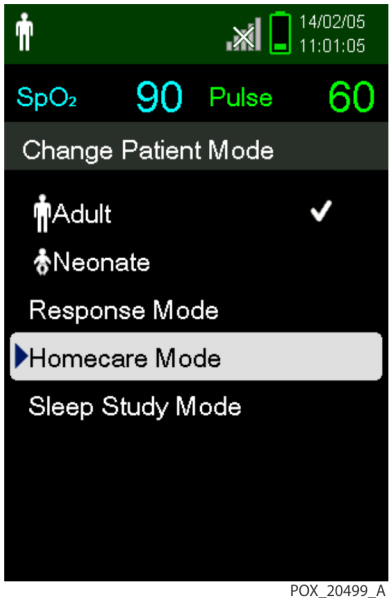
Icon	Patient mode
	Adult
	Neonatal
	Homecare (requires Homecare pass code)
	Sleep Study (requires Sleep Study pass code)

4.3.4 Homecare Mode

To verify Homecare Mode

1. Connect a sensor to the monitoring system and to a live subject.
2. Access the Change Patient Mode menu.
3. Press the Up or Down button to highlight Homecare Mode, then press OK to select Homecare Mode.

Figure 4-3. Homecare Mode Menu Item



POX_20499_A

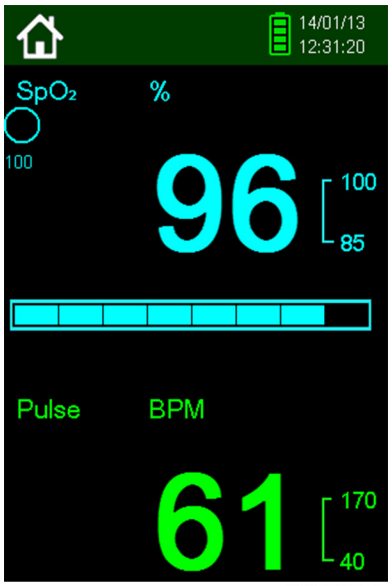
4. Enter the four-digit pass code for Homecare Mode.

   Use the Up and Down buttons to change the value for each digit, then press OK to select the value.

5. After entering the four digits, select Confirm to enter Homecare Mode.

6. Verify that the Homecare Mode screen appears. The Homecare Mode icon appears at top left of the screen, and the monitoring screen's appearance is different from the Standard Mode and Sleep Study Mode screens.

Figure 4-4. Homecare Mode Monitoring Screen



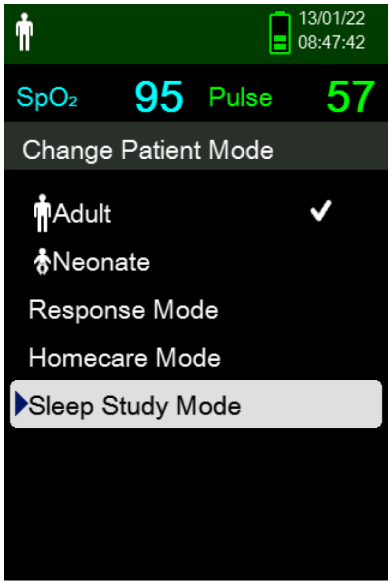
POX_20391_A

4.3.5 Sleep Study Mode

To verify Sleep Study Mode

1. Access the Change Patient Mode menu.
2. Press the Up or Down button to highlight Sleep Study Mode, then press OK to select Sleep Study Mode.

Figure 4-5. Sleep Study Mode Menu Item



3. Enter the four-digit pass code for Sleep Study Mode.

   Use the Up and Down buttons to change the value for each digit, then press OK to select the value.

4. After entering the four digits, select Confirm to enter Sleep Study Mode.

5. Verify that the Sleep Study Mode icon appears at top of screen.

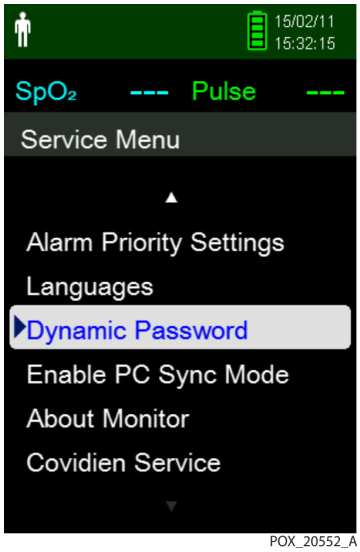
4.3.6 Dynamic Passwords

The Dynamic Password menu allows a user to set new pass codes for switching between care modes. The menu is accessible in Standard Mode, and requires access to the Service Menu. Contact Technical Services to obtain the default Service Menu pass code.

To change a dynamic password

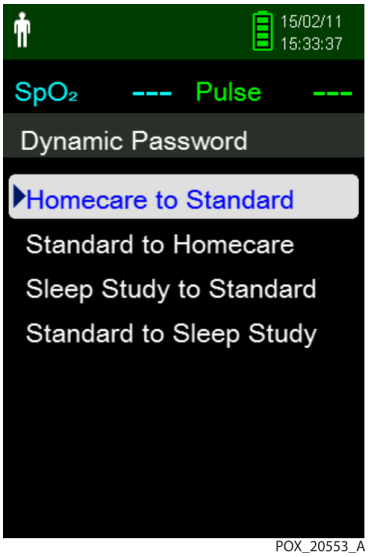
1. Select the Service Menu.
2. Enter the default pass code obtained from Technical Services.
3. From the Service Menu, use the Down button to highlight Dynamic Password, then press OK.

Figure 4-6. Service Menu



4. Highlight the mode transition for which the password is being changed, then press OK.

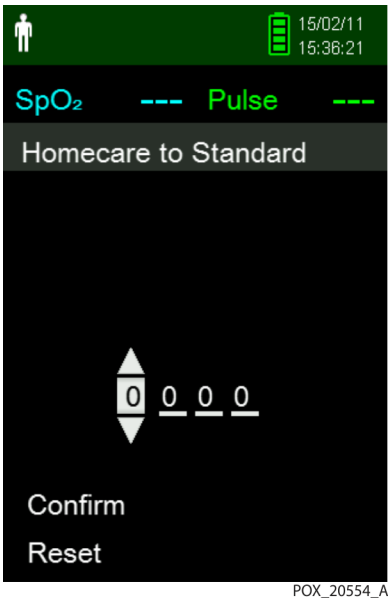
Figure 4-7. Dynamic Password Menu (Homecare to Standard Example)



5. Perform one of the following to set a new dynamic password or to reset the existing password to the factory default:

   - Enter a new password by pressing the Up and Down buttons to change the value for each digit, then select Confirm.
   - Select Reset to revert to the factory default password.

Figure 4-8. Password Set or Reset (Homecare to Standard Example)



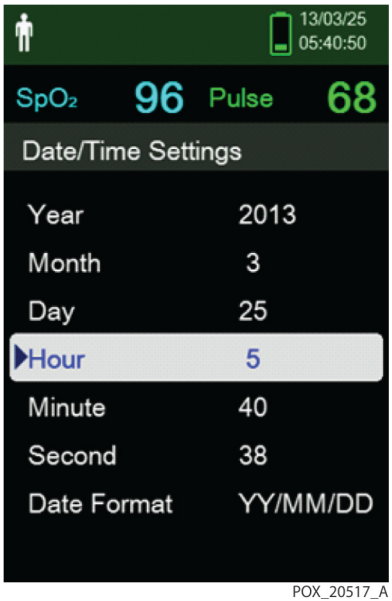
POX_20554_A

4.3.7 Date and Time

To verify the date and time are accurate

1. Select the Service Menu.
2. From the Service Menu, use the Down button to select the Date/Time Settings menu.

Figure 4-9. Date/Time Settings



POX_20517_A

3. Set the correct year, month, day, hour, and minute.
4. Use the Up button and Down button to scroll through the Date Format options. The options allow for changes in the date format (yy/mm/dd, mm/dd/yy, dd/mm/yy).
5. Verify that the selected year, month, day, hour, and minute appear at the top of the screen.

Note:
The time format is 24 hours only.

4.4 Operational and Functional Tests

4.4.1 General Operation Tests

To perform general operation tests

1. Set the monitoring system to Factory Defaults, which removes institutional default settings.

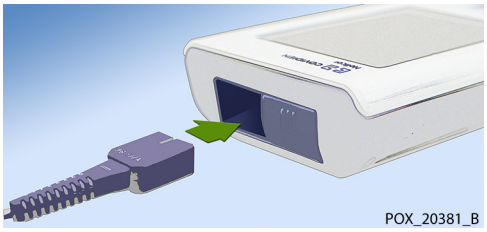
   For more information about factory defaults and options for saving monitoring system settings, reference the *Operator's Manual*.

2. Use a durable, adult finger sensor as specified in *Table 4-1 on page 4-2*.

LED Excitation Test

The LED excitation test uses normal system components to test circuit operation. The test uses the red sensor LED to verify intensity modulation controlled by the LED intensity control circuit. Use an adult finger sensor to examine LED intensity control.

Figure 4-10. Sensor Port



To test the circuit operation

1. Open the sensor port cover.
2. Connect a DEC-4 pulse oximetry cable to the sensor port.
3. Connect the adult finger sensor to the DEC-4 cable.
4. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system on.

5. Pinch the ends of the finger sensor to open the sensor to its widest point.
6. After the monitoring system completes POST, verify the finger sensor LED is brightly lit.
7. Allow the sensor clip to close slowly.
8. Verify the LED intensity decreases as the LED approaches the optical sensor.
9. Open the sensor again and verify that the LED intensity increases.
10. Repeat step *7* and verify the intensity continues to decrease. This variation is an indication the microprocessor is in proper control of LED intensity.
11. Leave the monitoring system on for the next test.

Operation with a Live Subject

Use the same finger sensor used in the *LED Excitation Test*, page 4-10 to perform the following test with a live subject.

To test using a live subject

1. Attach the finger sensor to a live subject as recommended in the OxiMax™ pulse oximetry sensor's instructions for use.
2. If not already done, press and hold the Power On/Off button to turn the monitoring system on and verify the monitoring system is operating.
3. The monitoring system should stabilize on the subject's physiological signal in about 15 to 30 seconds. Verify the oxygen saturation and pulse rate values are reasonable for the subject.

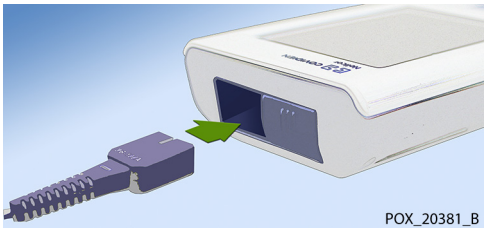
Alarms and Alarm Silenced

Access these settings from the Service Menu by using the pass code provided by Technical Services. Reference *Technical Services*, page 1-8.

To adjust the audio (alarms and alarm silenced) options

1. Connect the DEC-4 pulse oximetry cable to the monitoring system's sensor port.

Figure 4-11. Sensor Port

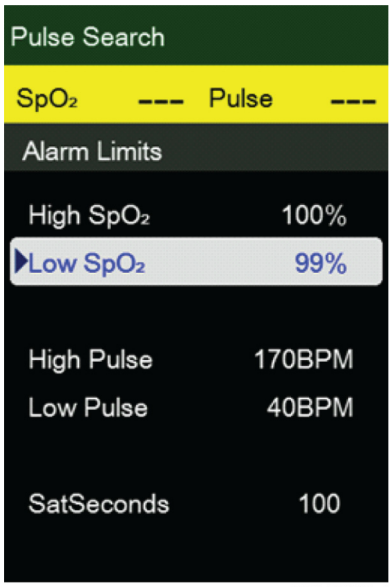


2. Connect the OxiMax™ DS-100A sensor to the DEC-4 cable, then to a finger.
3. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system on.

Alarm Silenced

1. Verify the SpO_2 and pulse rate appear.
2. Select the Alarm Limits menu.
3. Select Low SpO_2.
4. Change Low SpO_2 to 99%.

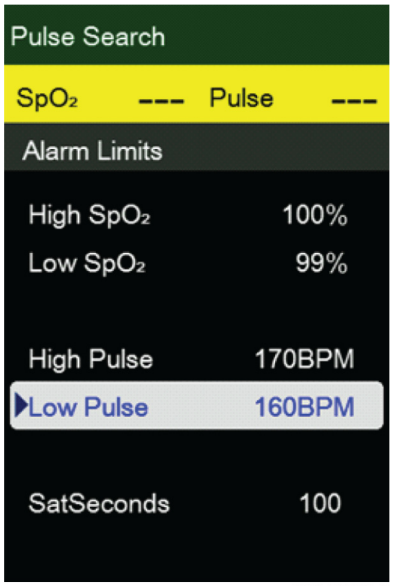
Figure 4-12. Low SpO_2 Alarm Limit of 99%



POX_20524_A

5. Select Low Pulse.
6. Change Low Pulse to 160 BPM.

Figure 4-13. Low Pulse Alarm Limit of 160BPM



7. Confirm the following results:

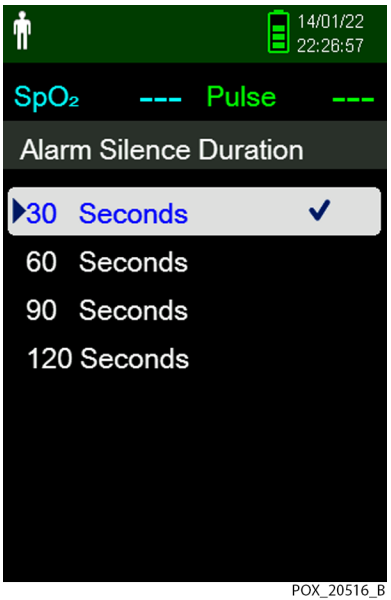
   - The waveform tracks the pulse rate.
   - The pulse tone is audible.
   - SpO_2 and pulse rate values have flashing yellow highlights behind them.

Note:
Depending on the live subject, an alarm might not be triggered using the Low SpO_2 alarm limit of 99%.

   - The audible alarm sounds.
   - The following messages alternately appear in the display: Pulse Rate Low and SpO_2 Low.

8. Access the Service Menu and set Alarm Silence Duration to 30 seconds.

Figure 4-14. Alarm Silence Duration Setting of 30 Seconds



9. Exit the Service Menu.

10. As soon as the SpO_2 Low and Pulse Rate Low alarms sound, press the Silence Alarm button to immediately silence the alarm tone.

11. With the alarm silenced, verify the following:

    - Alarm remains silent for 30 seconds before the alarm tone is audible.
    - Alarm Silenced indicator lights, and the Alarm Silenced message appears in the display.
    - SpO_2 and pulse rate values have flashing yellow highlights behind them.
    - The pulse tone is audible.

Permission to Mute Alarm

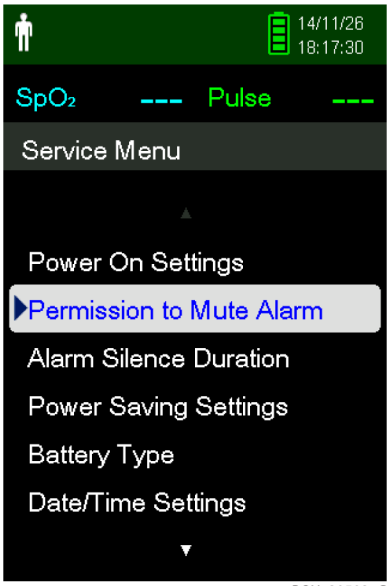
1. Use the same values for Low SpO_2 and PR alarm limits as described in *Alarm Silenced*, page 4-12.

2. Confirm the following results:

    - The pulse tone is audible.
    - The SpO_2 and pulse rate values are highlighted by flashing yellow boxes.
    - The audible alarm sounds.
    - The following messages alternately appear in the display: Pulse Rate Low and SpO_2 Low.

3. In the Service Menu, select Permission to Mute Alarm.

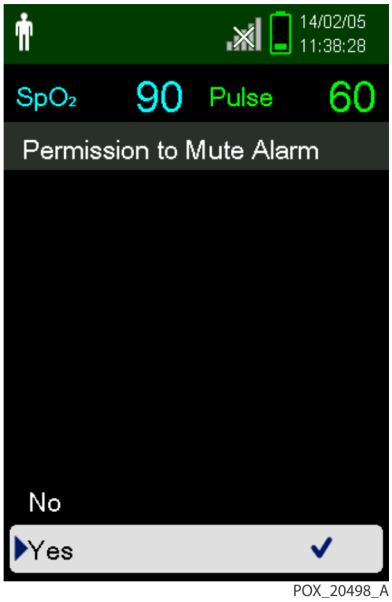
Figure 4-15. Permission to Mute Alarm



A confirmation message for the muted alarm setting appears.

4. Select Yes.

Figure 4-16. Confirmation for Muted Alarm



5. Exit the Service Menu.
6. Access the Device Settings menu.
7. In the Device Settings menu, access the Sound Settings menu.

8. In the Sound Settings menu, change the alarm volume to 0.
9. Verify the following:
   - Alarm audio is silent.
   - Alarm OFF indicator appears.
   - Pulse tone is audible.

Alarm Volume Control

After testing the Alarm Silenced and Permission to Mute Alarm settings, perform the following alarm volume test procedure.

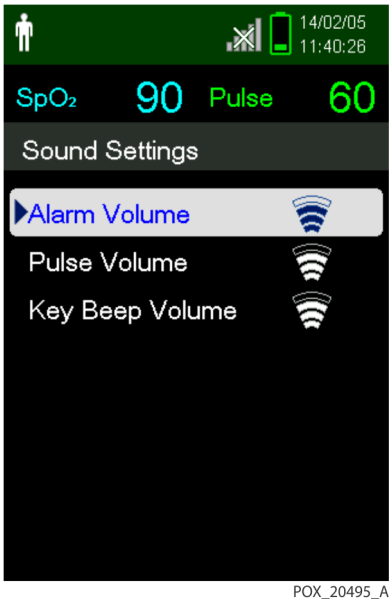
Note:
Turn the alarm audio back on for both SpO_2 and pulse rate before performing this procedure.

To test the alarm volume

1. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system off.
2. Connect the DEC-4 pulse oximetry cable to the sensor port.
3. Connect the OxiMax™ DS-100A sensor to the DEC-4 cable, then to a finger.
4. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system on.
5. Access the Device Settings menu.
6. In the Device Settings menu, access the Sound Settings menu.
7. Press the Down button to highlight Alarm Volume, then press OK.
8. Press the Up or Down button to adjust the alarm volume.

   The Alarm Volume setting controls the volume (1-4) of alarms. The default setting is 2.
9. To disable the audible alarm, change Permission to Mute Alarm to Yes in the Service Menu. Reference *Permission to Mute Alarm*, page 4-14.

Figure 4-17. Alarm Volume Default Setting of 2



Key Beep Volume Control

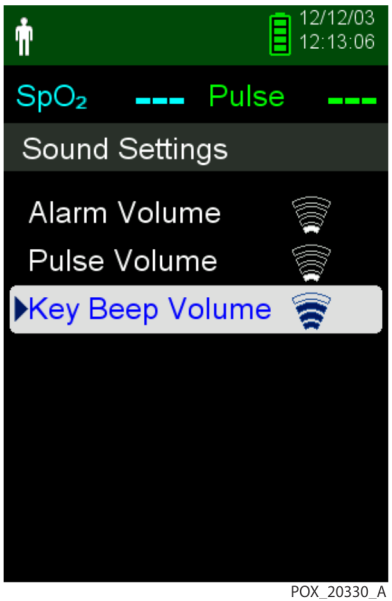
A beep sounds each time a button is pressed, unless the Key Beep Volume setting is 0.

To test the Key Beep volume

1. Access the Device Settings menu.
2. In the Device Settings menu, access the Sound Settings menu.
3. Press the Down button to highlight Key Beep Volume, then press OK.
4. Press the Up or Down button to adjust the key beep volume.

   The Key Beep Volume setting controls the volume (0-4) of key beeps. The default setting is 0.

Figure 4-18. Key Beep Volume Default Setting of 0



Pulse Volume Control

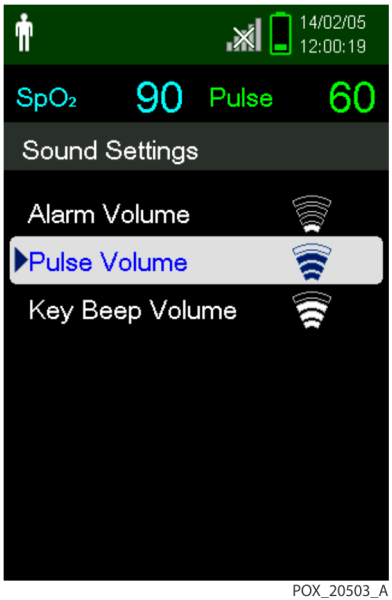
A pulse tone sounds with each detected heart beat.

To set the pulse volume

1. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system off.
2. Connect the DEC-4 pulse oximetry cable to the monitoring system sensor port.
3. Connect the OxiMax™ DS-100A sensor to the DEC-4 cable, then to a finger.
4. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system on.
5. Access the Device Settings menu.
6. In the Device Settings menu, access the Sound Settings menu.
7. Press the Down button to highlight Pulse Volume, then press OK.
8. Press the Up or Down button to adjust the pulse volume.

   The Pulse Volume setting controls the volume (0-4) of the pulse rate indicator. The default setting is 0.

Figure 4-19. Pulse Volume Default Setting of 0



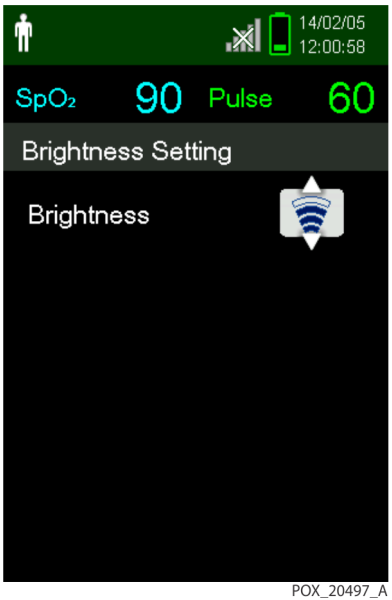
Brightness Control

Adjust the brightness of the display.

To adjust the Brightness

1. Access the Device Settings menu.
2. In the Device Settings menu, press the Up or Down button to highlight the Brightness Setting menu, and then press OK to select the Brightness Setting menu.

Figure 4-20. Brightness Setting



- Press the Down button to decrease the brightness.
- Press the Up button to increase the brightness.

3. Press OK to save the desired brightness.

Save Spot Reading

The Save Spot Reading function saves a point in time of the patient's data.

To save a spot reading

1. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system off.
2. Connect the DEC-4 pulse oximetry cable to the monitoring system sensor port.
3. Connect the OxiMax™ DS-100A sensor to the DEC-4 cable, then to a finger.
4. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system on.
5. Press Menu.
6. Highlight Save Spot Reading and press OK.

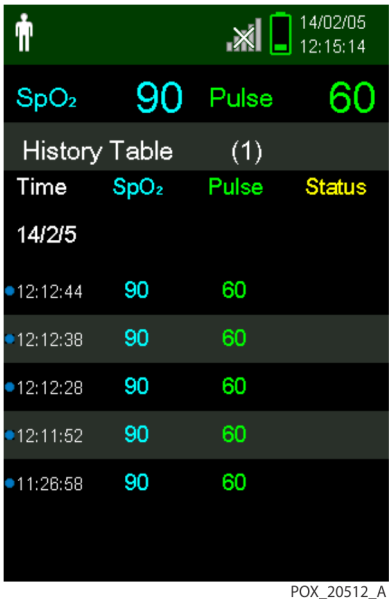
   The message "Spot Reading Saved" appears.

Figure 4-21. "Spot Reading Saved" Message

POX_20504_A

7. Access the Monitoring History menu.
8. In the Monitoring History menu, select View Spot Data.
9. Verify the saved spot readings.

Figure 4-22. Monitoring History Spot Data



POX_20512_A

Sensor Alarm Priority Settings

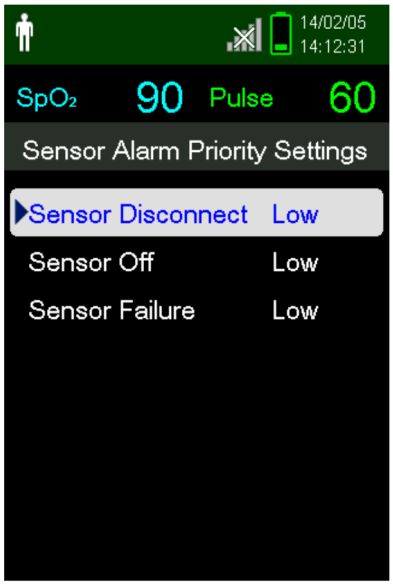
Access the Sensor Alarm Priority Settings menu to change the alarm priority to Low, Medium, or High for:

- Sensor Disconnect alarm
- Sensor Off alarm
- Sensor Failure alarm

To change the Alarm Priority Setting for Sensor Disconnect

1. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system off.
2. Connect the DEC-4 pulse oximetry cable to the monitoring system's sensor port.
3. Connect the OxiMax™ DS-100A sensor to the DEC-4 cable, then to a finger.
4. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system on.
5. When the SpO_2 saturation and pulse rate are displayed, disconnect the sensor from the monitoring system's sensor port.
6. Verify that the Sensor Disconnect alarm occurs.
7. Access the Service Menu.
8. In the Service Menu, select the Sensor Alarm Priority Settings menu.
9. Set the Sensor Disconnect priority to High.

Figure 4-23. Sensor Disconnect Alarm Priority Setting



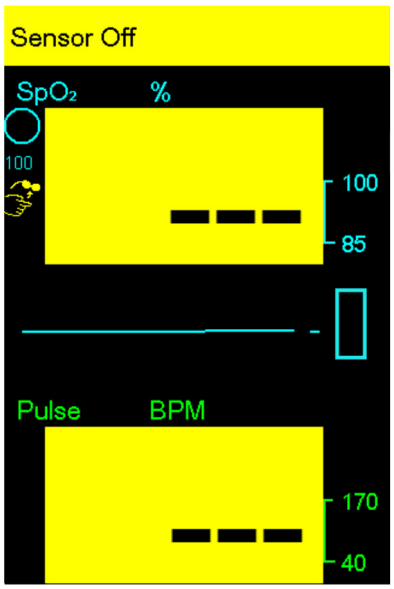
POX_20505_A

10. Observe the monitoring screen.
11. Verify the following:
    - The SpO_2 and pulse rate values are highlighted by flashing red boxes.
    - The High priority alarm sounds.
    - The message “Sensor Disconnect” appears.

To change the Alarm Priority Setting for Sensor Off

1. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system off.
2. Connect the DEC-4 pulse oximetry cable to the monitoring system’s sensor port.
3. Connect the OxiMax™ DS-100A sensor to the DEC-4 cable, then to a finger.
4. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system on.
5. When the monitoring system is powered on, disconnect the sensor from the finger.
6. Verify that the Sensor Off alarm occurs.

Figure 4-24. Sensor Off Alarm



POX_20530_A

7. Access the Service Menu.
8. In the Service Menu, select the Sensor Alarm Priority Settings menu.
9. Set the Sensor Off priority to High.
10. Go to the monitoring screen.

11. Verify the following:

    - The SpO_2 and pulse rate values are highlighted by flashing red boxes.
    - The High priority alarm sounds.
    - The message “Sensor Off” appears.

Screen Saver

Screen Saver saves power by darkening the screen.

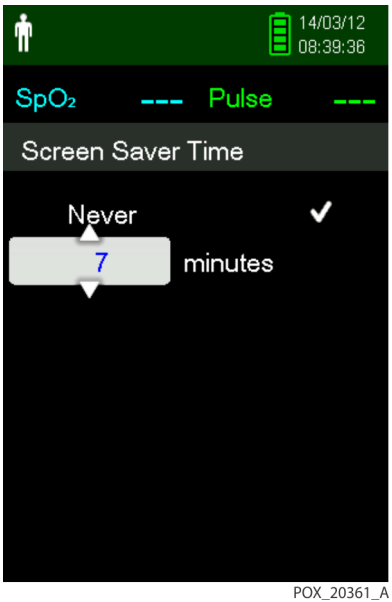
The Screen Saver functions during periods when no alarm condition exists and the buttons are not pressed.

To set the Screen Saver

1. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system on.
2. Access the Service Menu.
3. In the Service Menu, select the Power Saving Settings menu.
4. Select Screen Saver Time. The factory default is 3 minutes.
5. Set the desired number of minutes.

   Screen Saver Time selections include Never and from 1 minute to 10 minutes.

Figure 4-25. Screen Saver Time Setting



POX_20361_A

6. In the Power Saving Settings menu, select the Screen Saver Brightness menu.

7. Change the brightness to 0. The factory default is 20%.
8. After 1 minute, verify the following:
   - The screen of the monitoring system is darkened.
   - The LED is flashing green.
9. After pressing any button or when an alarm occurs, verify the following:
   - The screen of the monitoring system is brightened.
   - The LED lights green.

Power Saving

Power Saving turns the screen off after 10 minutes of inactivity.

Power Saving functions when no alarm condition exists and the buttons are not pressed.

To test the Power Saving

1. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system off.
2. Connect the DEC-4 pulse oximetry cable to the monitoring system's sensor port.
3. Connect the OxiMax™ DS-100A sensor to the DEC-4 cable, then to a finger.
4. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system on.
5. After 10 minutes, verify the following:
   - The screen of the monitoring system is turned off.
   - The LED is flashing at 2.5-second intervals.
6. After pressing any button except the Power On/Off or Silence Alarm button, verify the following:
   - The brightness of the screen is set to the desired brightness.
   - The LED lights green.

Auto Power Off

Auto Power Off turns the monitoring system off after the specified period of inactivity.

Auto Power Off functions when no alarm condition exists, the buttons are not pressed for the specified period, the sensor is disconnected, and the sensor signal is lost.

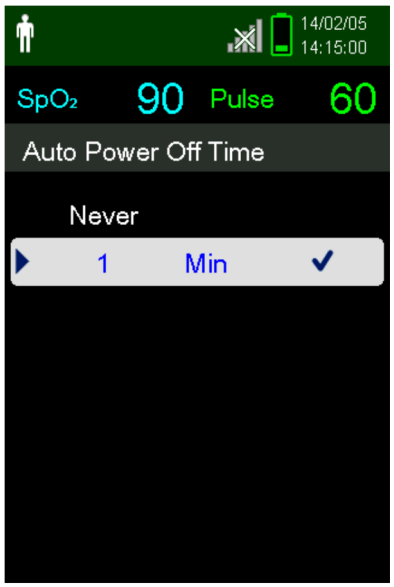
To test Auto Power Off

1. Press and hold the Power On/Off button for approximately 1 second to turn the monitoring system on.
2. Access the Service Menu.

3. In the Service Menu, select the Power Saving Settings menu.
4. Select the Auto Power Off Time menu. The factory default is 3 minutes.
5. Set 1 minute in the Auto Power Off Time menu.

   Auto Power Off selections include Never and from 1 minute to 10 minutes.

Figure 4-26. Auto Power Off Time Setting



POX_20496_A

6. After 1 minute, verify the following:
   - The LED is off.
   - The monitoring system turns off automatically.

4.4.2 Functional Tests

To perform functional tests

1. Read *SRC-MAX Overview*, page 4-27 to become familiar with the pulse oximetry functional tester (Nellcor™ model SRC-MAX).

Note:
For the waveform tests, the display will show a pulse waveform of approximately 1/2-inch peak to peak (P-T-P) amplitude. Actual amplitude may vary but will be a reference for low pulse amplitude/low light patients.

2. Once the SRC-MAX is attached to the DEC-4 cable and the SRC-MAX and monitoring system are turned on, complete all of the tests in sequence, beginning with BPM (PR), then %SpO_2, then Modulation, and finally Light Level.

SRC-MAX Overview

WARNING:
The SRC-MAX is a functional tester that verifies operation of the monitoring system. It cannot be used to assess the accuracy of the monitoring system's %SpO_2 and pulse rate readings.

The SRC-MAX functional tester enables qualified technicians to functionally test Nellcor™ and OEM OxiMax™ technology-based monitoring systems. *Table 4-3* provides a brief description of each test.

Table 4-3. Functional Tests with SRC-MAX

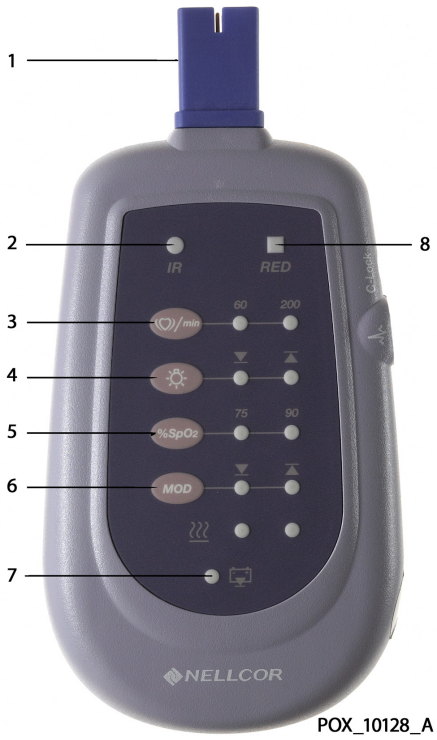
Tests	Descriptions
BPM Test	The test procedure simulates an OxiMax™ pulse oximetry sensor attached to a patient indicating a pulse rate of 60 BPM and 200 BPM.
%SpO_2 Test	The test procedure simulates an OxiMax™ pulse oximetry sensor attached to a patient indicating a 75% blood oxygen saturation and a 90% blood oxygen saturation.
Modulation Level Test	The test procedure simulates an OxiMax™ pulse oximetry sensor attached to a patient indicating low and high pulse strength.
Light Level Test	The test procedure simulates an OxiMax™ pulse oximetry sensor attached to a patient indicating low and high light level passing through the patient at the sensor site.

Note:
The SRC-MAX selectable indicator LEDs may extinguish if there is a delay in proceeding through the above tests. This is normal operation to conserve battery power.

Note:
Pressing a button on the SRC-MAX during the test procedures may be requested to change a certain parameter. If the SRC-MAX LEDs are not lit, press the button twice. Pressing the button once causes the indicators to relight and pressing twice initiates the change.

Note:
As the SRC-MAX tests run, if the SatSeconds™ setting is any value other than 0, the visual and audible alarms will not activate until the SatSeconds™ circle is full.

Figure 4-27. SRC-MAX Oximetry Tester

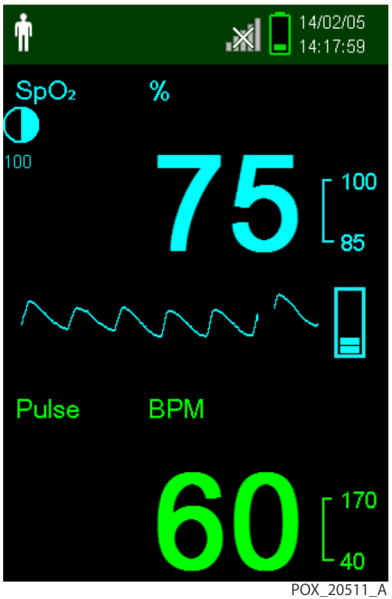


1	DEC-4 cable connector	5	%SpO_2 select button
2	Infrared LED drive indicator	6	% Modulation select button
3	Pulse rate selection button	7	Battery Low indicator
4	Light level selection button	8	Red LED drive indicator

BPM (PR) Test

1. With the monitoring system turned off, connect the DEC-4 pulse oximetry cable to the sensor port.
2. Connect the SRC-MAX tester to the other end of the DEC-4 cable.
3. Turn on the monitoring system by pressing and holding the Power On/Off button. Wait for the monitoring system to complete POST.

Figure 4-28. SRC-MAX Tester-Generated Waveform



4. Verify the following:

   a. Audio alarm is active.

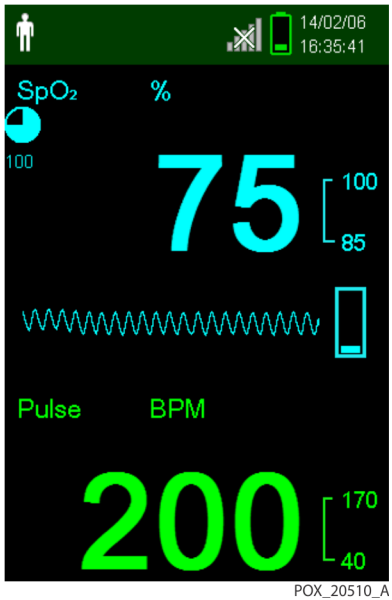
   b. Flashing %SpO_2 indication in the range of 73 to 77.

   c. BPM indication in the range of 57 to 63.

   d. Pulse waveform of approximately 1/2-inch peak to peak (P-T-P) amplitude.

5. Press the SRC-MAX PULSE RATE selection button. The SRC-MAX PULSE RATE 200 LED lights. The monitoring system registers that the BPM increases and stabilizes to a value in the range of 197 to 203 BPM.

Figure 4-29. SRC-MAX Increase to 200 BPM



POX_20510_A

6. Verify the following:

   a. Active audio alarm.

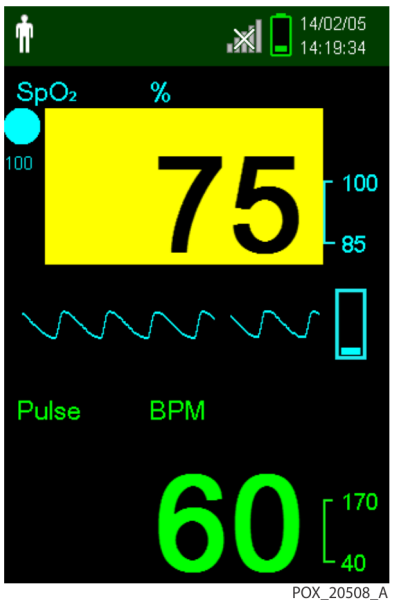
   b. Flashing %SpO_2 indication in the range of 73 to 77.

   c. Flashing BPM indication in the range of 197 to 203.

   d. Pulse waveform of approximately 1/2-inch P-T-P amplitude.

7. Press the SRC-MAX PULSE RATE selection button. The SRC-MAX PULSE RATE 60 LED lights. The pulse oximeter registers that the BPM decreases and stabilizes to a value in the range of 57 to 63 BPM.

Figure 4-30. SRC-MAX Decrease to 60 BPM



POX_20508_A

8. Verify the following:

   a. Active audio alarm.

   b. Flashing %SpO_2 indication in the range of 73 to 77.

   c. BPM indication in the range of 57 to 63.

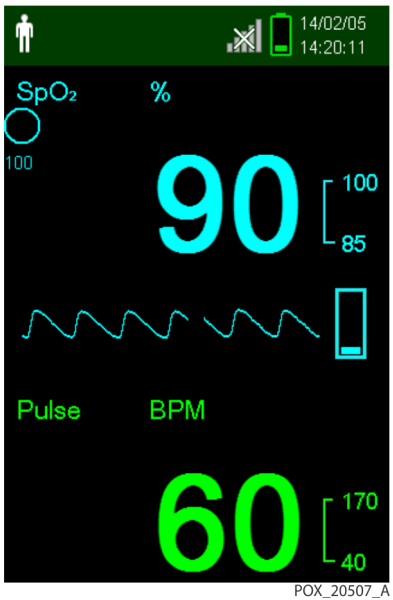
   d. Pulse waveform of approximately 1/2-inch P-T-P amplitude.

SpO_2 Test

%SpO2

1. Press the SRC-MAX %SpO_2 selection button. The SRC-MAX %SpO_2 90 LED lights. The monitoring system displays three dashes [- - -] until the %SpO_2 stabilizes at a value in the range of 88 to 92.

Figure 4-31. SRC-MAX %SpO_2 Increase to 90



2. Verify the following:

   a. No audio alarm.

   b. %SpO_2 indication in the range of 88 to 92.

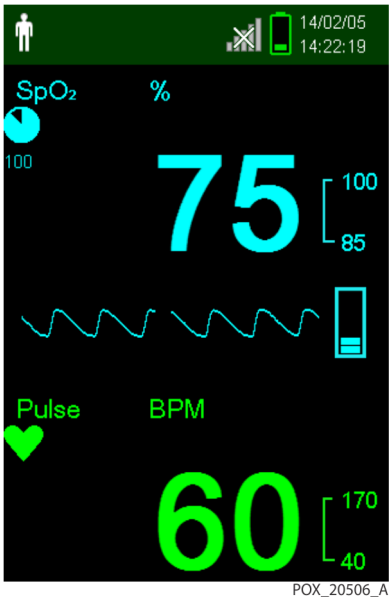
   c. BPM indication in the range of 57 to 63.

   d. Pulse waveform of approximately 1/2-inch P-T-P amplitude.

%SpO2

3. Press the SRC-MAX %SpO_2 selection button. The SRC-MAX %SpO_2 75 LED lights. The monitoring system displays three dashes [- - -] until the %SpO_2 stabilizes at a value in the range of 73 to 77.

Figure 4-32. SRC-MAX %SpO_2 Decrease to 75



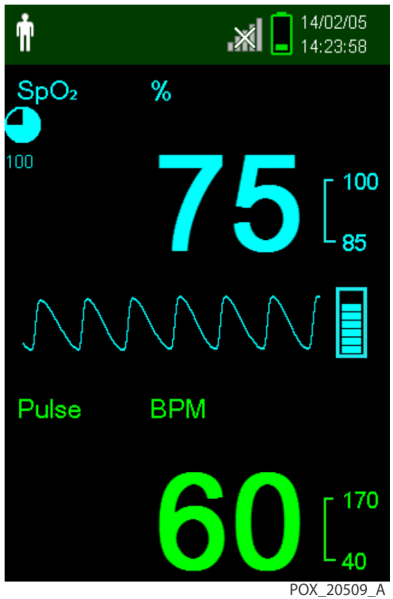
4. Verify the following:
   a. Active audio alarm.
   b. Flashing %SpO_2 indication in the range of 73 to 77.
   c. BPM indication in the range of 57 to 63.
   d. Pulse waveform of approximately 1/2-inch P-T-P amplitude.

Modulation Level Test

1. Press the SRC-MAX MODULATION selection button.

   The SRC-MAX MODULATION LED lights. The pulse amplitude waveform increases in amplitude and then stabilizes at a P-T-P amplitude of approximately 1 inch.

Figure 4-33. SRC-MAX High Modulation



2. Verify the following:

   a. Active audio alarm.

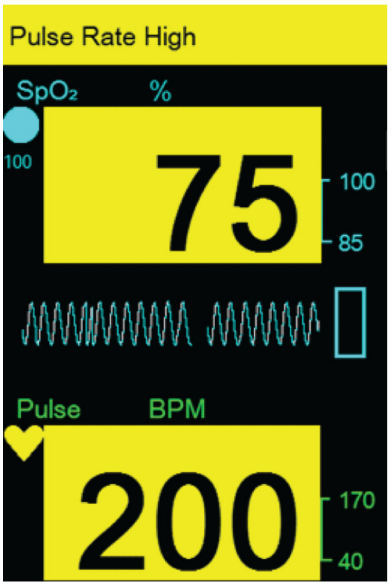
   b. Flashing %SpO_2 indication in the range of 73 to 77.

   c. BPM indication in the range of 57 to 63.

   d. Pulse waveform of approximately 1-inch P-T-P amplitude.

3. Press the SRC-MAX PULSE RATE selection button. The SRC-MAX PULSE RATE 200 LED lights. The pulse oximeter registers that the BPM increases and stabilizes to a value in the range of 197 to 203.

Figure 4-34. BPM of 200 with High Modulation



4. Verify the following:

   a. Active audio alarm.

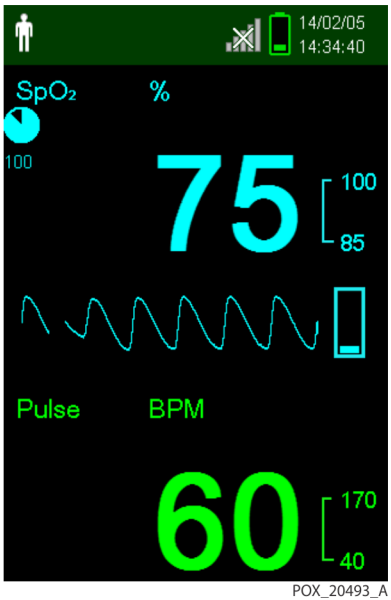
   b. Flashing %SpO_2 indication in the range of 73 to 77.

   c. Flashing BPM indication in the range of 197 to 203.

   d. Pulse waveform of approximately 1-inch P-T-P amplitude.

5. Press the SRC-MAX PULSE RATE selection button. The SRC-MAX PULSE RATE 60 LED lights. The monitoring system registers that the pulse rate decreases and stabilizes at a value in the range of 57 to 63.

Figure 4-35. BPM of 60 with High Modulation



6. Verify the following:

   a. Active audio alarm.

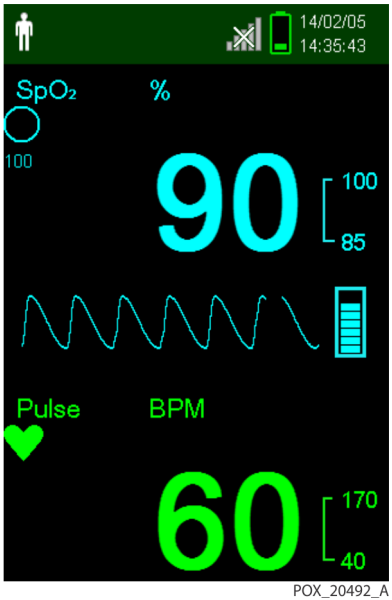
   b. Flashing %SpO_2 indication in the range of 73 to 77.

   c. BPM indication in the range of 57 to 63.

   d. Pulse waveform of approximately 1-inch P-T-P amplitude.

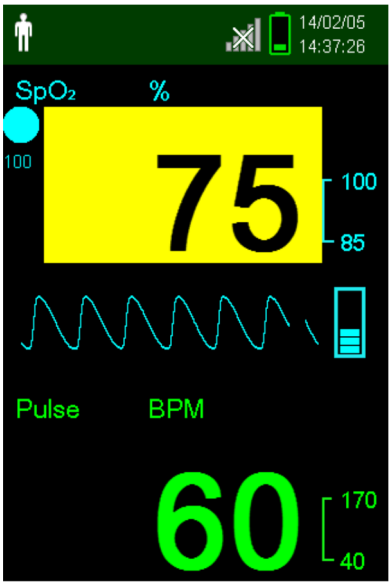
7. Press the SRC-MAX %SpO_2 selection button. The SRC-MAX %SpO_2 90 LED lights. The monitoring system displays three dashes [- - -] until the %SpO_2 stabilizes to a value in the range of 88 to 92.

Figure 4-36. %SpO_2 of 90 with High Modulation



8. Verify the following:
   a. No active audio alarm.
   b. %SpO_2 indication in the range of 88 to 92.
   c. BPM indication in the range of 57 to 63.
   d. Pulse waveform of approximately 1-inch P-T-P amplitude.
9. Press the SRC-MAX %SpO_2 selection button. The SRC-MAX %SpO_2 75 LED lights. The pulse oximeter displays three dashes [- - -] until the %SpO_2 stabilizes to a value in the range of 73 to 77.

Figure 4-37. %SpO_2 of 75 with High Modulation



10. Verify the following:

    a. Active audio alarm.

    b. Flashing %SpO_2 indication in the range of 73 to 77.

    c. BPM indication in the range of 57 to 63.

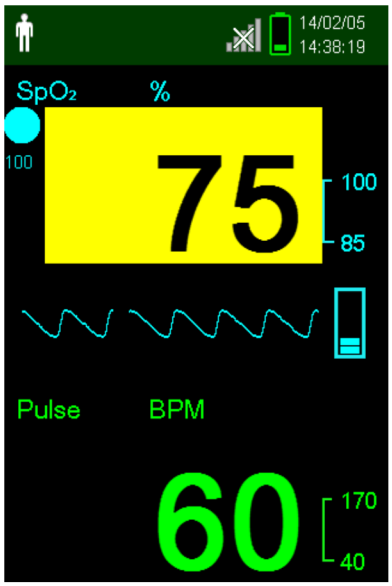
    d. Pulse waveform of approximately 1-inch P-T-P amplitude.

MOD

11. Press the SRC-MAX MODULATION selection button. The SRC-MAX MODULATION LED lights. The pulse amplitude waveform decreases in amplitude and the stabilizes at a P-T-P amplitude of approximately 1/2 inch.

Note:
The readings may drop out temporarily.

Figure 4-38. %SpO_2 of 75 with Low Modulation



12. Verify the following:

    a. Active audio alarm.

    b. Flashing %SpO_2 indication in the range of 73 to 77.

    c. BPM indication in the range of 57 to 63.

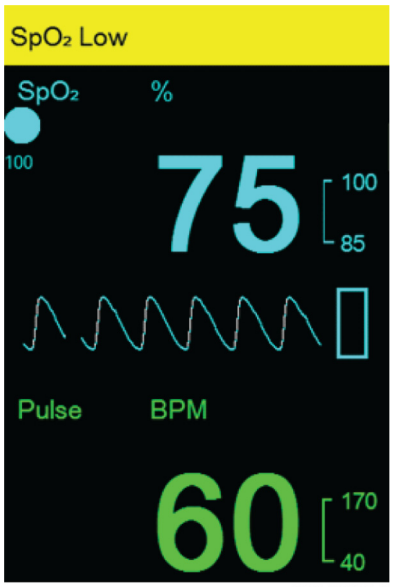
    d. Pulse waveform of approximately 1/2-inch P-T-P amplitude.

Light Level Test

1. Press the SRC-MAX LIGHT LEVEL selection button. The SRC-MAX LIGHT LEVEL LED lights. The waveform amplitude initially flatlines and then stabilizes at the previous amplitude.

Note:
Flatlining is the only indication of a light change at the measurement site. For the monitoring system to recover and display normally is an indication of proper operation with light changes.

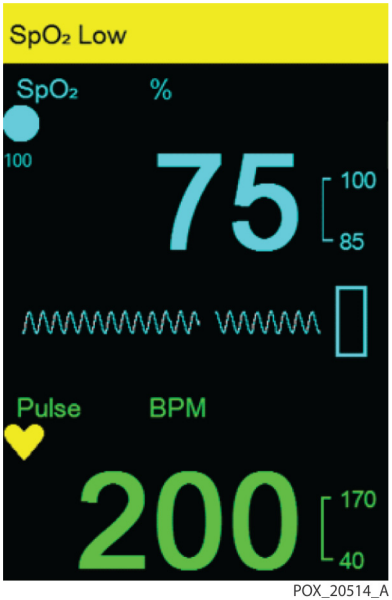
Figure 4-39. High Light Condition



POX_20520_A

2. Verify the following:
   a. Active audio alarm.
   b. Flashing %SpO_2 indication in the range of 73 to 77.
   c. BPM indication in the range of 57 to 63.
   d. Pulse waveform of approximately 1/2-inch P-T-P amplitude.
3. Press the SRC-MAX PULSE RATE selection button. The SRC-MAX PULSE RATE 200 LED lights. The monitoring system registers that the BPM increases and then stabilizes at a value in the range of 197 to 203.

Figure 4-40. BPM of 200 with High Light Condition



4. Verify the following:

   a. Active audio alarm.

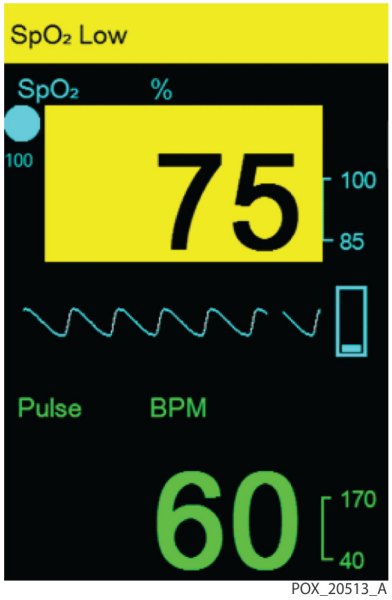
   b. Flashing %SpO_2 indication in the range of 73 to 77.

   c. Flashing BPM indication in the range of 197 to 203.

   d. Pulse waveform of approximately 1/2-inch P-T-P amplitude.

5. Press the SRC-MAX PULSE RATE selection button. The SRC-MAX PULSE RATE 60 LED lights. The monitoring system registers that the pulse rate decreases and then stabilizes at a value in the range of 57 to 63.

Figure 4-41. BPM of 60 with High Light Condition



6. Verify the following:

   a. Active audio alarm.

   b. Flashing %SpO_2 indication in the range of 73 to 77.

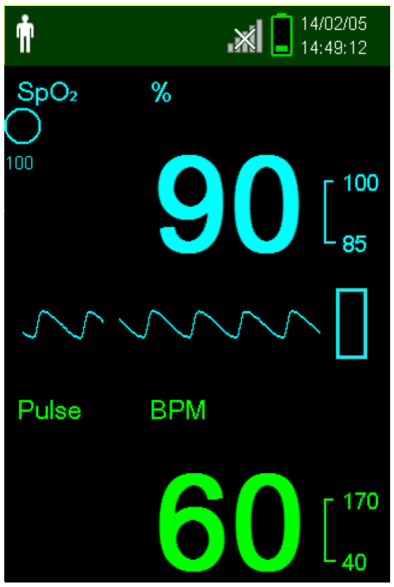
   c. BPM indication in the range of 57 to 63.

   d. Pulse waveform of approximately 1/2-inch P-T-P amplitude.

%SpO2

7. Press the SRC-MAX %SpO_2 selection button. The SRC-MAX %SpO_2 90 LED lights. The monitoring system displays three dashes [- - -] until the %SpO_2 stabilizes to a value in the range of 88 to 92.

Figure 4-42. %SpO_2 of 90 with High Light Condition



POX_20531_A

8. Verify the following:

   a. No audio alarm.

   b. %SpO_2 indication in the range of 88 to 92.

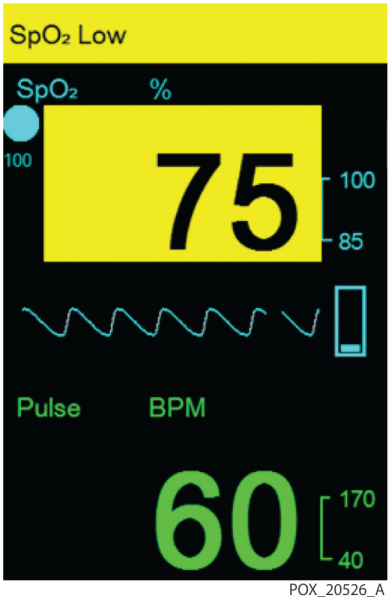
   c. BPM indication in the range of 57 to 63.

   d. Pulse waveform of approximately 1/2-inch P-T-P amplitude.

%SpO2

9. Press the SRC-MAX %SpO_2 selection button. The SRC-MAX %SpO_2 75 LED lights. The monitoring system displays three dashes [- - -] until the %SpO_2 stabilizes to a value in the range of 73 to 77.

Figure 4-43. %SpO_2 of 75 with High Light Condition



10. Verify the following:

    a. Active audio alarm.

    b. Flashing %SpO_2 indication in the range of 73 to 77.

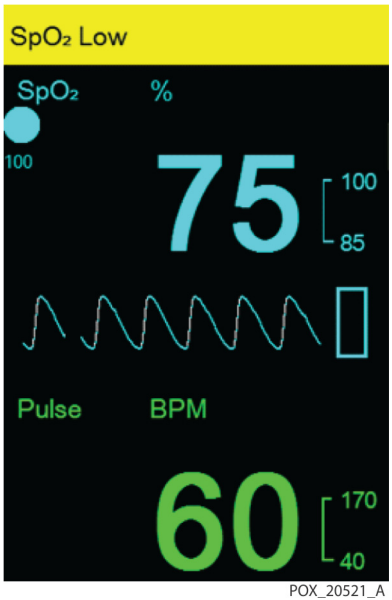
    c. BPM indication in the range of 57 to 63.

    d. Pulse waveform of approximately 1/2-inch P-T-P amplitude.

MOD

11. Press the SRC-MAX MODULATION selection button. The SRC-MAX MODULATION LED lights. The monitoring system's pulse waveform increases in amplitude and then stabilizes at a P-T-P amplitude of approximately 1 inch.

Figure 4-44. High Modulation and High Light Condition



12. Verify the following:
    a. Active audio alarm.
    b. Flashing %SpO_2 indication in the range of 73 to 77.
    c. BPM indication in the range of 57 to 63.
    d. Pulse waveform of approximately 1-inch P-T-P amplitude.
13. Reset the Power On Settings to Factory Defaults. Doing so removes any saved settings and clears the Last Setting option.
14. Turn off the monitoring system.

4.5 Verification Check Sheets

Model name		Serial number		Software version	

Performance, Operation, and Functional Test Results

Item	Results	Remarks
Performance tests		
Power-on self-test (POST)	Pass / Fail	
Battery status	Pass / Fail	
Patient modes	Pass / Fail	
Date and time	Pass / Fail	
Homecare Mode	Pass / Fail	
Sleep Study Mode	Pass / Fail	
General operation tests		
LED excitation	Pass / Fail	
Operation with a live subject	Pass / Fail	
Alarms and alarm silenced	Pass / Fail	
Alarm volume control	Pass / Fail	
Key beep volume control	Pass / Fail	
Pulse volume control	Pass / Fail	
Brightness control	Pass / Fail	
Save Spot Reading	Pass / Fail	
Sensor Disconnect alarm priority	Pass / Fail	
Sensor Off alarm priority	Pass / Fail	
Screen saver	Pass / Fail	
Power saving	Pass / Fail	
Auto power off	Pass / Fail	
Functional tests		
SpO_2 90 +/- 2%	Pass / Fail	Value: %

SpO_2 75 +/- 2%	Pass / Fail	Value: %
Pulse rate 200 +/- 3 bpm (high priority alarm condition)	Pass / Fail	Value: bpm
Pulse rate 60 +/- 3 bpm	Pass / Fail	Value: bpm
Modulation level	Pass / Fail	
Light level	Pass / Fail	
TESTS PERFORMED BY:	**SIGNATURE and DATE:**	

5 Troubleshooting

5.1 Overview

WARNING:
Only a qualified service technician should remove the cover or access or replace any internal parts.

This chapter describes how to troubleshoot common problems that may occur while using the Nellcor™ portable SpO_2 patient monitoring system.

5.2 Troubleshooting Guide

Potential problems with the monitoring system are separated into categories and listed in *Table 5-1 on page 5-2*.

General guidelines for troubleshooting:

- Taking the recommended actions discussed in this section will correct the majority of problems that might be encountered. When the recommended action is to replace a part, reference *Chapter 6, Repair*.
- Problems not covered in this section can be resolved by calling Covidien Technical Services. Reference *Technical Services*, page 1-8.
- If Technical Service recommends returning the monitoring system for repair, reference *Return*, page 5-8 for packing instructions.

5.2.1 Error Conditions by Category

Table 5-1. Error Conditions and Resolutions

Error condition by category	Cause or checkpoint	Corrective action
Power		
Monitoring system does not turn on when Power On/Off button is pressed.	Monitoring system's Power On/Off button must be held for 1 second.	Press and hold the Power On/Off button for 1 second.
	Battery is not properly seated.	Check that the battery polarity is correct and that all batteries are seated.
	Depleted battery or unsuitable battery.	Ensure all batteries are 1.5V.
		If problem persists, replace the batteries.
Low battery/critically low battery condition	Monitoring system has been run on battery power for the life of the battery.	Replace the batteries.
	Unsuitable battery.	Ensure all batteries are 1.5V.
NELL-1 malfunction		
Monitoring system is frozen.	Reset needed.	Press and hold the Power On/Off button for 10 seconds to force the system to turn off. Turn the monitoring system on again.
	Main board is malfunctioning.	If problem persists, replace the main board.
Monitoring system message: System Failure (920)	Monitoring system opened and harnesses disconnected.	Press and hold the Power On/Off button for 1 second to turn the monitoring system off. Turn the monitoring system on again. Verify normal POST.
	Batteries depleted.	
	Battery disconnected while monitoring system was powered on.	
Display		
Blank display after normal POST	LCD cable is disconnected.	Reconnect the LCD cable.
	LCD is damaged.	Replace the LCD.
Display does not function properly or looks distorted.	Electromagnetic interference.	Isolate sources of electromagnetic interference (electrosurgical device, cell phone).
	LCD cable disconnected or improperly connected.	Reconnect or reseat LCD cable.
	Main board is malfunctioning.	Replace the main board.
LCD is visibly cracked or broken.		Replace LCD.

Table 5-1. Error Conditions and Resolutions (Continued)

Error condition by category	Cause or checkpoint	Corrective action
Sound		
No sound during POST	Speaker cable is loose or disconnected.	Reseat speaker cable in main board.
	Speaker is malfunctioning.	Ensure connector on main board is firmly seated. If problem persists, replace speaker.
	Main board is malfunctioning.	Replace main board.
Buzzer sounds during POST, monitoring system message: System Failure (910)	Speaker cable is disconnected.	Ensure the speaker cable is connected to main board.
	Speaker is malfunctioning or main board is malfunctioning.	Test the short circuit in a speaker by using the digital multi meter. If there is a short in the speaker, replace the speaker. If not, replace the main board.
Audio alarm cannot be silenced.	Main board is malfunctioning.	Replace the main board.
	Keypad is damaged.	Replace the front case assembly.
Audio alarm does not silence for the time specified in the Institutional Default settings.	Institutional defaults not set correctly.	Reset institutional defaults.
	Silence Alarm button activator on main board is malfunctioning.	Replace the main board.
Buttons		
No response when control buttons are pressed	Keypad ribbon cable not making contact.	Check that the keypad ribbon cable is connected to main board.
	System is frozen.	Press and hold the Power On/Off button for 10 seconds to restart.
	Buttons are defective.	Replace the front case assembly.
	Button activators on main board are malfunctioning.	Replace the main board.
SpO_2 / sensor		
Sensor messages: SpO_2 Pulse Search SpO_2 Sensor Off SpO_2 Cable/Sensor Disconnect Signal Artifact Detected	Sensor disconnected from cable or monitoring system.	Check all connections.
	Detached from patient.	Reposition sensor and secure cable.
	Unable to get reliable readings because of substances on patient's skin or nails, or because of excessive patient motion.	Remove items of interference (electrosurgical device, cell phone, nail polish, cream).
		If problems persist, replace the cable or sensor.

Table 5-1. Error Conditions and Resolutions (Continued)

Error condition by category	Cause or checkpoint	Corrective action
Patient data / USB data port		
Questionable readouts of patient physiological measurements; wrongly tagged or missing patient data	Sensor not attached correctly.	Check all connections and reposition if necessary.
	Sensor is malfunctioning.	Replace sensor or cable.
	Electromagnetic interference.	Remove sources of electromagnetic interference (electrosurgical device, cell phone).
	Ambient light interfering with proper sensing.	Remove excessive ambient light.
	Coin cell battery was removed from main board. **WARNING**: Replacing the coin cell battery for the main board resets the monitoring system's date and time settings. Integrity of existing patient data will be questionable.	Replace coin cell battery with known good battery. Delete monitoring history. Set date and time for locale and time zone.
USB data port does not function properly.	USB cable not firmly connected.	Ensure USB cable is firmly connected. Disconnect USB cable, reset system power, then reconnect.
	Covidien bridge driver corrupted.	Re-install the bridge driver provided by Covidien.
	Mismatched baud rates between monitoring system and PC.	Ensure baud rate settings for both monitoring system and PC are the same.
	Mismatched COM port between PC and the HyperTerminal™* program.	Ensure same COM port is selected on PC and the HyperTerminal™* program or other data transmission tool.
	USB port damaged.	Ensure there is no physical damage to USB port. If damaged, replace main board.
	Main board failure.	Replace the main board.

Table 5-1. Error Conditions and Resolutions (Continued)

Error condition by category	Cause or checkpoint	Corrective action
Date and time incorrect on LCD and in monitoring history download.	Date and time not set correctly during installation.	Set date and time for locale and time zone.
	Coin cell battery depleted or removed and replaced.	If date and time reset unexpectedly, replace coin cell battery with known good battery and reset date and time. **WARNING**: If the monitoring system's date and time have been reset or were not set correctly on installation, integrity of existing patient data will be questionable. Delete existing data immediately after replacing the battery and setting the date and time.
	Coin cell battery tab in main board does not provide firm contact.	If problems persist, verify the coin cell battery is snug against the tab on the main board. If not, replace the main board.
	Main board failure.	Replace main board.
System failure message and error code appear on display.	Firmware is not loading correctly.	Reference *Table 5-2 on page 5-6*.
	Monitoring system is malfunctioning.	If error persists, do not use the monitoring system; record error code, then contact Covidien Technical Services.

Note:
Reference Alarms and Alarm Limits Management in the operator's manual for any issues related to alarm conditions.

5.2.2 System Error Codes

When the monitoring system detects an error condition, an error code is displayed on the LCD.

Table 5-2 provides a list of system error codes and problem identification. If an error code occurs, turn the monitoring system off and then on again.

Note:
If the alarm message still appears, record the error code, take the monitoring system out of service, and contact Covidien Technical Services for advice on remedial action. Reference *Technical Services*, page 1-8.

Table 5-2. System Error Codes

Code	Technical error condition
001	SpO_2 front end RAM error
002	SpO_2 front end ROM/code integrity error
004	SpO_2 front end reports command not allowed.
005	SpO_2 front end reports illegal value sent by SpO_2 back end.
006	SpO_2 front end reports calibration (offset) failure.
010	Over-current limit in SpO_2 front end has tripped.
012	SpO_2 front end reports other hardware problem.
017	SpO_2 front end reports other hardware problem.
018	SpO_2 front end reports internal register modified from expected value.
048	SpO_2 front end reports spurious interrupt detected.
050	SpO_2 front end reports internal software consistency check failed.
051	SpO_2 front end reports DigiCAL communications error.
256	SpO_2 back end reports beginning of packet missing.
257	SpO_2 back end reports packet state ID (SID) missing.
258	SpO_2 back end reports packet length error.
259	SpO_2 back end reports message length error.
260	SpO_2 back end reports packet contains unsupported Key.
261	SpO_2 back end reports packet CRC error.
262	SpO_2 back end reports end of packet missing.
263	SpO_2 back end reports packet contains undefined Key.
264	SpO_2 back end reports corrupted variable.

Table 5-2. System Error Codes (Continued)

Code	Technical error condition
265	SpO_2 back end reports memory overflow.
266	SpO_2 back end reports bad pointer.
267	SpO_2 back end reports parameter value out-of-range.
268	SpO_2 back end reports reset detected.
269	SpO_2 back end reports unexpected value.
270	SpO_2 back end reports timeout.
271	SpO_2 back end reports not ready/not initialized.
272	SpO_2 back end reports double fault.
273	SpO_2 back end reports data out of range error.
274	SpO_2 back end reports incompatible software version.
275	SpO_2 back end reports incorrect registration number.
276	SpO_2 back end reports sensor read failure.
277	SpO_2 back end reports sensor signature verification fails.
280	SpO_2 back end reports does not support feature required by sensor.
281	SpO_2 back end reports overflow/underflow.
282	SpO_2 back end reports sensor activation failure.
283	SpO_2 back end reports sensor write failure.
284	Host is providing both HW and SW ECG triggers.
285	Host attempted Read or Close of Sensor Event before successful Open.
286	Host attempted redundant Open of Sensor Event.
287	An error occurred with the Sensor Event data and is unavailable for reading by the Host.
288	No more Sensor Event data available for reading by Host, i.e., Host has read all available Sensor Event data.
289	Sensor Private Label/Host Sensor Key incompatible; will not operate sensor.
512	SpO_2 back end reports internal software consistency check failed.
513	SpO_2 back end reports software functions executed before initialization completed.
514	SpO_2 back end reports internal memory buffer overflow.
516	SpO_2 back end ROM/code integrity error
517	SpO_2 back end RAM error
518	SpO_2 back end reports internal software consistency check failed.

Table 5-2. System Error Codes (Continued)

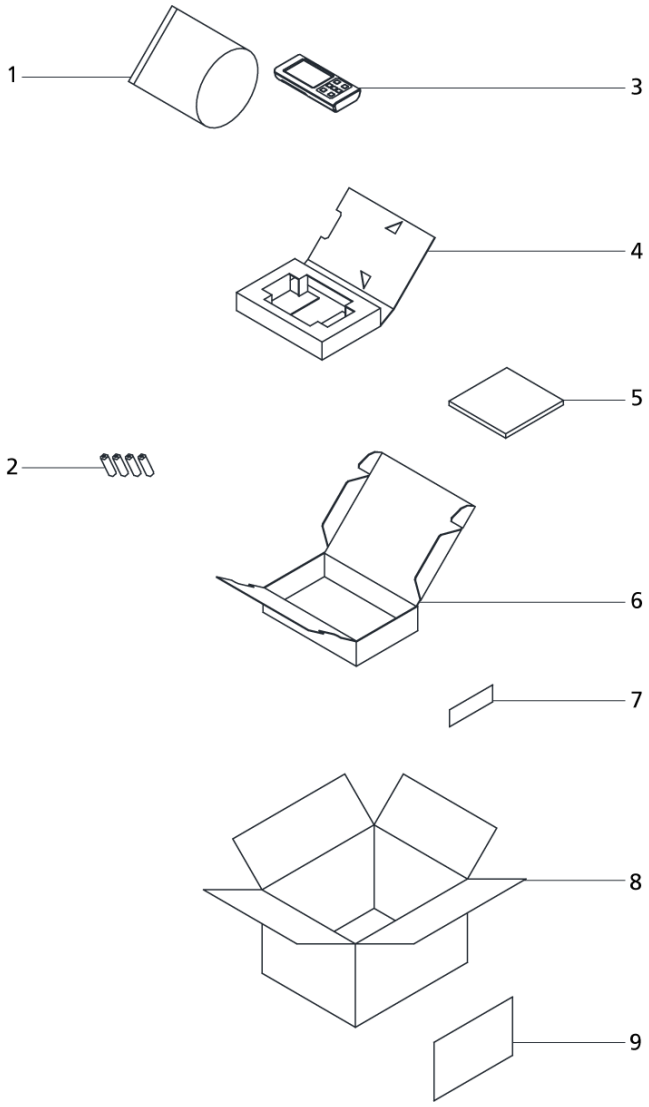
Code	Technical error condition
519	SpO_2 back end reports a state machine is in an unexpected state.
520	SpO_2 back end reports memory corruption detected.
521	SpO_2 back end reports spurious interrupt detected.
522	SpO_2 back end reports unable to issue commands to SpO_2 front end.
523	SpO_2 back end reports unable to write to external Flash.
524	SpO_2 back end reports that communication with SpO_2 front end lost.
525	SpO_2 back end reports internal register modified from expected value.
701	Flash writing transaction error
901	SpO_2 module communication error/setting value mismatch error between host and SpO_2 module
902	Program memory error
903	RAM error
904	PSRAM error
905	Sub MCU communication error
907	RTC error
908	Serial flash memory error
909	Internal voltage error
910	Sound/speaker error
912	LCD error
913	Button error
920	Abnormally shut down last time

5.3 Return

Contact Covidien or a local Covidien representative for shipping instructions, including a Returned Goods Authorization (RGA) number. Reference *Obtaining Technical Assistance*, page 1-8. Unless otherwise instructed by Covidien, it is not necessary to return sensors or other accessory items with the monitoring system.

Pack the monitoring system in its original shipping carton, as shown in *Figure 5-1 on page 5-9*. If the original carton is not available, use a suitable carton with the appropriate packing material to protect the monitoring system during shipping. Return the monitoring system by any shipping method that provides proof of delivery.

Figure 5-1. Return Packaging



1	Roll bag	6	Product box — outer
2	Four AA batteries	7	Product box label
3	Nellcor™ portable SpO_2 patient monitoring system	8	Shipping box
4	Product box — inner	9	Shipping box label
5	Home use guide		

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6 Repair

6.1 Overview

WARNING:
To avoid possible injury, do not attempt to service the monitoring system if there are any signs of burning or smoking coming from the monitoring system.

WARNING:
To prevent possible electric shock or explosion, do not service the monitoring system in a flammable environment or in an excessively moist environment.

WARNING:
Only a qualified service technician should remove the cover or access or replace any internal parts.

WARNING:
Before attempting to open or disassemble the monitoring system, disconnect the power cord from the monitoring system to avoid possible injury.

This chapter provides trained service technicians with information about how to repair the Nellcor™ portable SpO_2 patient monitoring system.

Major component parts include:

- Batteries
- Printed circuit boards (“boards”)
- LCD
- Front and rear housing assemblies

Note:
Some spare parts come with an enclosed business reply card. After receiving the spare parts, please complete and return the business reply card.

6.2 Spare Parts and Accessories

Covidien Technical Services provides technical assistance and replacement parts. Contact Covidien or your local Covidien representative to obtain replacement parts. Reference *Technical Services*, page 1-8 for contact information.

When ordering parts, refer to them by the part names and part numbers, as shown in *Figure 6-1* and listed in *Table 6-1*. A listing of the spare parts and accessories for the monitoring system is also available at:

www.covidien.com

An electronic, printable copy of this manual is also available at this site.

Figure 6-1 shows an exploded view of the monitoring system. Reference *Table 6-1* for descriptions and part numbers for each spare part.

Figure 6-1. Exploded View

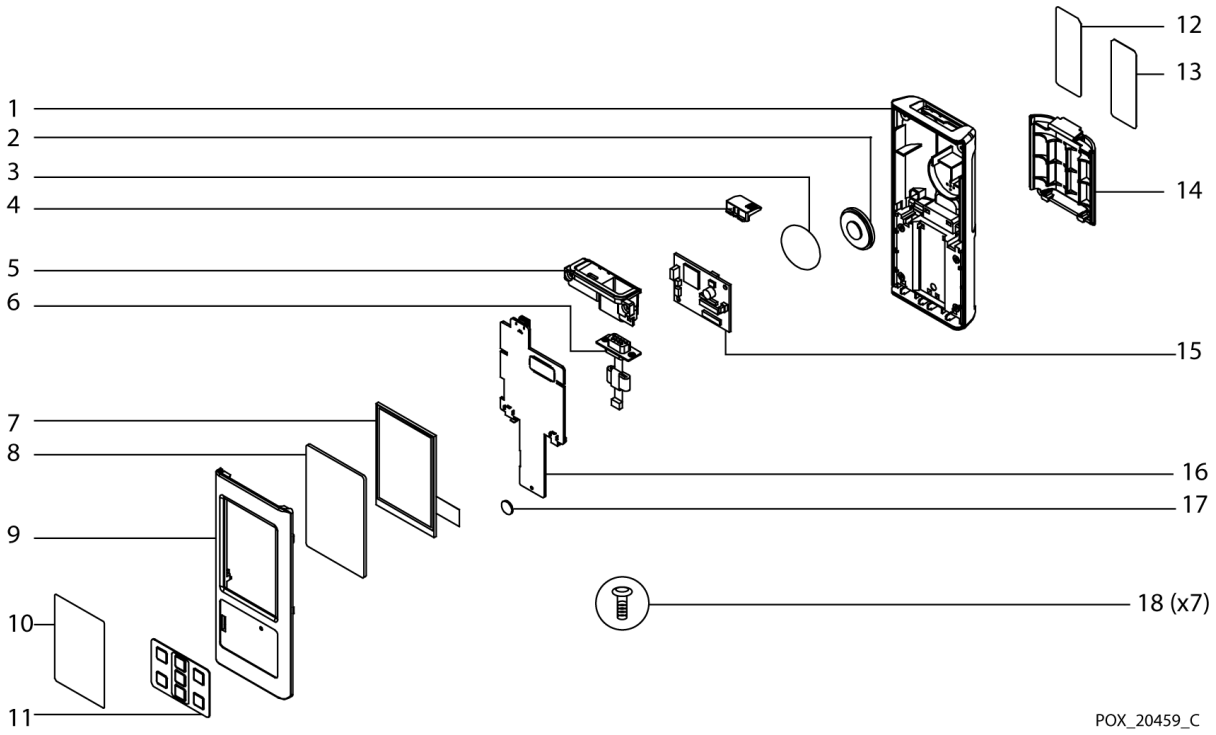


Table 6-1. Spare Parts List by Callout Number

Item	Description	Spare part name	Assembly part number
1	Rear case	Rear housing assembly	PT00092777
2	Speaker		
3	Speaker insulation sheet		

Table 6-1. Spare Parts List by Callout Number (Continued)

Item	Description	Spare part name	Assembly part number
4	Slide cover (for USB and sensor ports)	Slide cover	10113039
5	PI cable housing	PI cable housing	10121872
6	PI cable		
	Screws (x2)		
7	LCD	LCD assembly	10113035
8	LCD window	LCD window assembly	10126549
10	LCD window protective film		
9	Front case	Front housing assembly	10113036
11	Keypad		
12	Serial number label	Serial number label, blank	10113040
13	Product label	Product label	10109104
14	Battery compartment cover	Battery cover	PT00092776
15	NELL1SR SpO_2 circuit board	NELL1SR board	SPNELL1SR
16	Main circuit board	Main board	PT00092774
17	Lithium coin cell battery	Coin cell battery	10022884
18	Housing screw	Screws (x7)	PT00092775
(not shown)	Battery contacts with terminals	FRU, Battery Contacts, PM10N	PT00092778
(not shown)	2x6 screws bag	2x6 bind head housing screws bag	PT00093132

Figure 6-2. Standard Cover (3 Shown) and Ambulatory Cover

Table 6-2. Monitoring System Accessories

Description	Part number
Protective boot - standard, dark blue	PMAC10N-N
Protective boot - standard, light blue (not shown)	PMAC10N-B
Protective boot - standard, pink	PMAC10N-P
Protective boot - standard, green	PMAC10N-G
Protective boot - ambulatory	PMAC10N-T
Carabiner with ring (not shown)	10115703
Carrying case (not shown)	PMAC10N-CC
Velcro loop (not shown)	10112033
USB cable for firmware upgrades (not shown)	10091181

6.3 Required Tools

Collect the following tools before disassembling the monitoring system:

- #1 Phillips screwdriver
- Small flat-blade screwdriver (suggested, not required)

6.4 Battery Replacement

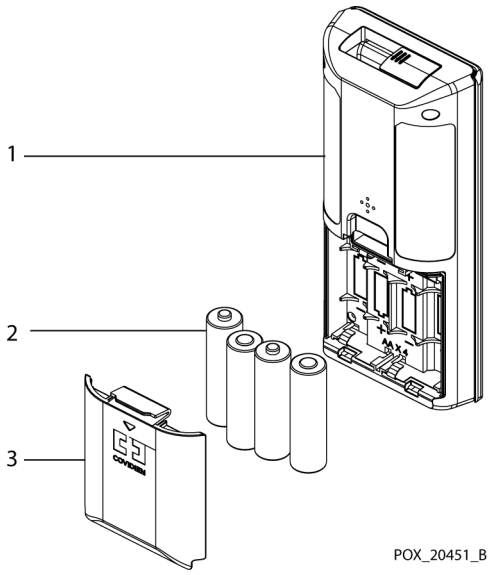
WARNING:
Explosion hazard — Use only AA size batteries. Do not use different types or models of batteries together, such as dry batteries, nickel-metal hydride batteries, or lithium-ion batteries.

The monitoring system comes with four AA lithium batteries. You can replace depleted batteries with lithium or alkaline batteries. By default, the monitoring system uses lithium batteries. If replacing with alkaline batteries, change the Battery Type setting through the Service Menu to optimize power usage. Reference *Service Menu Overview*, page 2-1.

6.4.1 Remove the Batteries

1. Turn the monitoring system off.
2. Remove the battery cover (3) on the rear housing.
3. Remove the four AA batteries (2).

Figure 6-3. Battery Replacement



6.4.2 Replace the Batteries

Caution:
Use only AA size batteries.

Reference *Figure 6-3*:

1. Insert four AA batteries. Ensure the correct orientation of each battery (+/-).
2. Close the battery cover.

6.5 Disassembly and Reassembly

WARNING:
Only qualified service personnel should open the monitoring system casing, remove and replace components, or make adjustments. If your medical facility does not have a qualified service technician, please contact Covidien Technical Services or your local Covidien representative.

WARNING:
Before attempting to open or disassemble the monitoring system, remove the batteries to prevent possible injury.

WARNING:
No user-serviceable parts inside.

Caution:
Observe ESD (electrostatic discharge) precautions when working within the monitoring system.

The supported replacement level for the monitoring system is to the printed circuit board ("board") and major subassembly level. After isolating the problem to a suspected board, follow the procedures in *Front and Rear Assembly Replacement*, page 6-6, then replace the faulty board with a known good board. Verify the symptom disappears and ensure the monitoring system passes all performance tests. If the symptom persists, swap the replacement board with the suspected malfunctioning board (the original board installed when you started troubleshooting) and continue troubleshooting.

6.5.1 Front and Rear Assembly Replacement

Caution:
Observe ESD (electrostatic discharge) precautions when disassembling and reassembling the monitoring system and when handling any of its components.

Caution:
Ensure the work surface is clean and free of debris.

Note:
The batteries should be replaced before monitoring system repairs when possible.

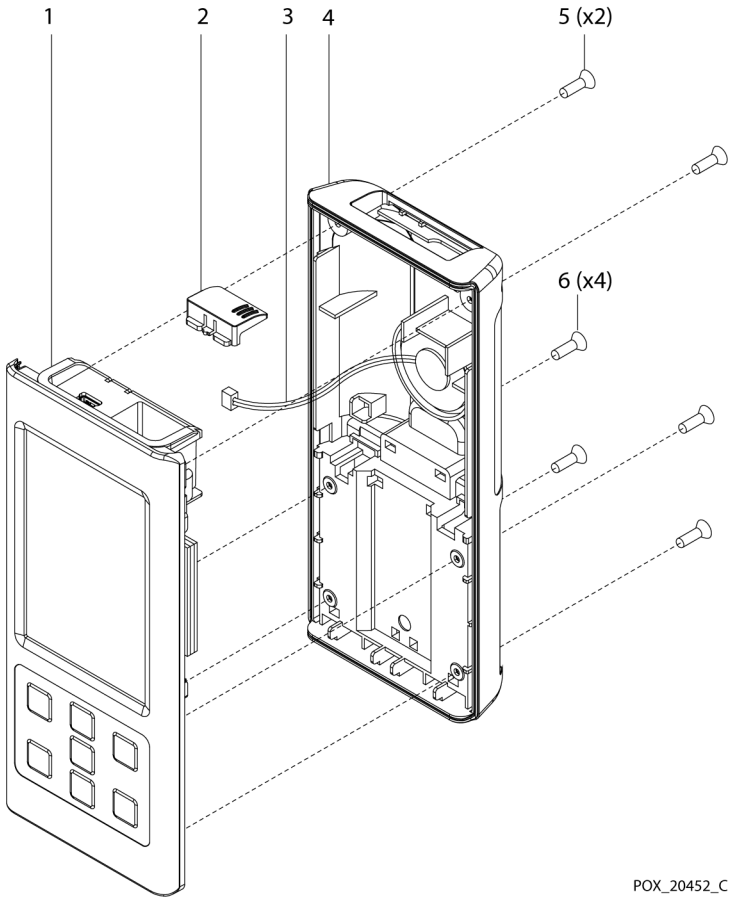
Disassemble the Front and Rear Assemblies

1. Turn the monitoring system off.
2. Remove the batteries. Reference *Battery Replacement*, page 6-4.
3. Using the #1 Phillips screwdriver, remove the six screws (5) and (6) from the rear assembly.

Note:
The top left and right screws are 2x8 mm screws. The four screws in the battery compartment are 2x6 mm screws. Set aside these two sets of screws separately for reassembly.

4. Carefully separate the front assembly (1) from the rear assembly (4).
5. Disconnect the speaker harness (3) from the main board.
6. Separate the slide cover (2) from the front and rear assembly.
7. Place the two halves of the monitoring system on a static-free work surface.

Figure 6-4. Front and Rear Assembly Replacement



Reassemble the Front and Rear Assemblies

Caution:
Over-tightening could strip out the screw holes, rendering the rear assembly unusable.

Reference *Figure 6-4* on page 6-7:

1. Place the monitoring system's slide cover (2) inside the rear assembly.
2. Connect the speaker harness (3) to the main board.
3. Gently align and place the front assembly (1) onto the rear assembly (4).
4. Replace the two screws (5) in the rear assembly with 2x8 mm screws. Tighten each one to 2.0 ± 0.5 kgf-cm.
5. Replace the four screws (6) in the battery compartment with 2x6 mm screws. Tighten each one to 2.0 ± 0.5 kgf-cm.
6. Replace the batteries. Reference *Replace the Batteries*, page 6-5.

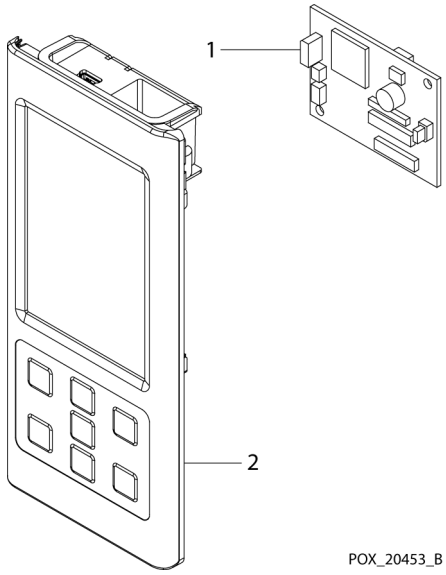
6.5.2 NELL1SR Board Replacement

Remove the NELL1SR Board

Caution:
When removing the NELL1SR board from the main board, avoid bending the connector pins.

1. Turn the monitoring system off.
2. Complete the steps in *Remove the Batteries*, page 6-5.
3. Complete the steps in *Disassemble the Front and Rear Assemblies*, page 6-7.
4. Lay the front assembly face down on a static-free work surface.
5. Carefully separate the NELL1SR board (1) from the main board (2).

Figure 6-5. NELL1SR Board Replacement



Replace the NELL1SR Board

Caution:
The NELL1SR board can only be installed one way. Ensure that the pins for each connector are properly aligned.

Reference *Figure 6-5*:

1. Align the connectors on the NELL1SR board (1) with the connectors on the main board (2) as follows:
   - Align the NELL1SR J4 connector with the J10 connector on the main board.
   - Align the NELL1SR J5 connector with the J12 connector on the main board.

   Press the NELL1SR board down to seat the connectors.
2. Complete the steps in *Reassemble the Front and Rear Assemblies*, page 6-8.
3. Complete the steps in *Replace the Batteries*, page 6-5.

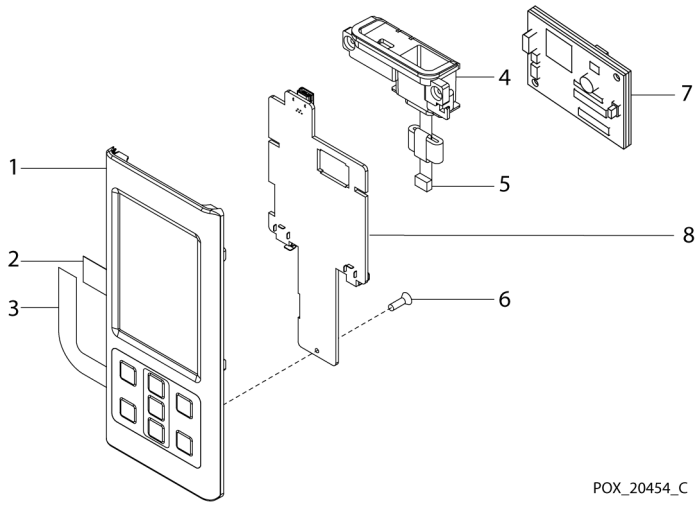
6.5.3 Main Board Replacement

Remove the Main Board

1. Turn the monitoring system off.
2. Complete the steps in *Remove the Batteries*, page 6-5.
3. Complete the steps in *Disassemble the Front and Rear Assemblies*, page 6-7.

4. Move the rear assembly off to the side, retaining the front assembly (1) on the static-free work surface.
5. Remove the NELL1SR board (7) from the main board as described in *Remove the NELL1SR Board*, page 6-8.
6. Disconnect the PI cable (5) from the main board.
7. Slide the connector housing (4) from the main board.
8. Disconnect the LCD cable (2) from the main board.
9. Disconnect the keypad cable (3) from the main board.
10. Using the #1 Phillips screwdriver, remove the single screw (6) holding the main board to the front housing.

Figure 6-6. Main Board Replacement



Replace the Main Board

Reference *Figure 6-6*:

1. Using the #1 Phillips screwdriver, insert the single 2x6 mm screw (6) into the main board (8) and into the screw hole in the front housing (1). Tighten the screw to 2.0 ± 0.5 kgf-cm.
2. To replace the connector housing (4), connect the PI cable (5) on the connector housing to the main board.
3. Connect the keypad cable (3) to the J8 connector on the main board.
4. Connect the LCD cable (2) to the J7 connector on the main board.
5. Complete the steps in *Reassemble the Front and Rear Assemblies*, page 6-8.
6. Complete the steps in *Replace the Batteries*, page 6-5.

6.5.4 Coin Cell Battery Replacement

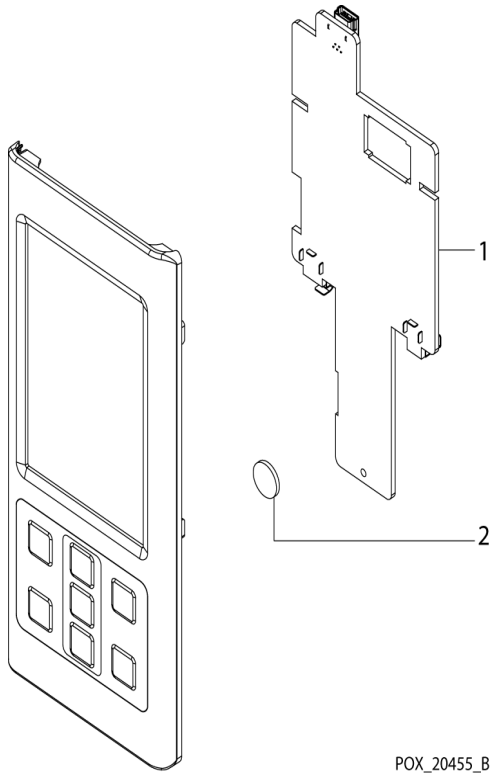
WARNING:
Replacing the coin cell battery for the main board resets the monitoring system's date and time. Integrity of existing patient data will be questionable. Set the monitoring system to the correct date and time after replacing this battery with a known good battery.

The coin cell battery is located on the main board.

Remove the Coin Cell Battery

1. Complete the steps in *Remove the Main Board*, page 6-9.
2. Place the main board (1), with the coin cell battery side up, on the static-free work surface.
3. Using a small, flat-blade screwdriver, press the locking tab for the coin cell battery (2) away from the coin cell battery until the battery is free.

Figure 6-7. Coin Cell Battery Replacement



Replace the Coin Cell Battery

1. Position the new battery with the positive side facing up. The positive side has printing and a plus sign (+) stamped into it.

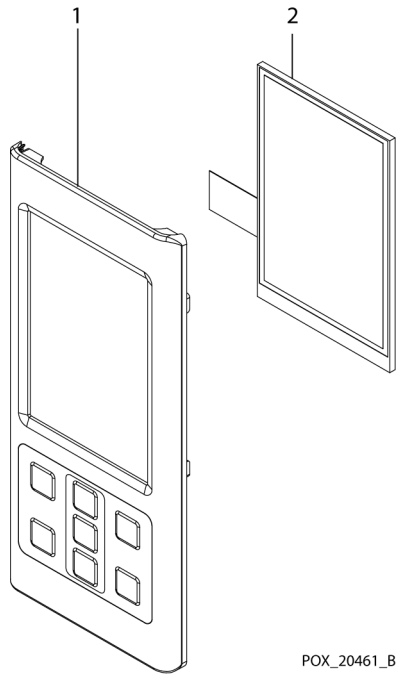
2. Press the coin cell battery (2) into place on the main board (1) until the locking tab clicks.
3. Complete the steps in *Replace the Main Board*, page 6-10.

6.5.5 LCD Replacement

Remove the LCD

1. Turn the monitoring system off.
2. Complete the steps in *Remove the Batteries*, page 6-5.
3. Complete the steps in *Disassemble the Front and Rear Assemblies*, page 6-7.
4. Complete the steps in *Remove the Main Board*, page 6-9.
5. Separate the LCD (2) from the front housing (1).

Figure 6-8. LCD Replacement



Replace the LCD

1. Place the new LCD (2) on the front housing (1).
2. Complete the steps in *Replace the Main Board*, page 6-10.
3. Complete the steps in *Reassemble the Front and Rear Assemblies*, page 6-8.

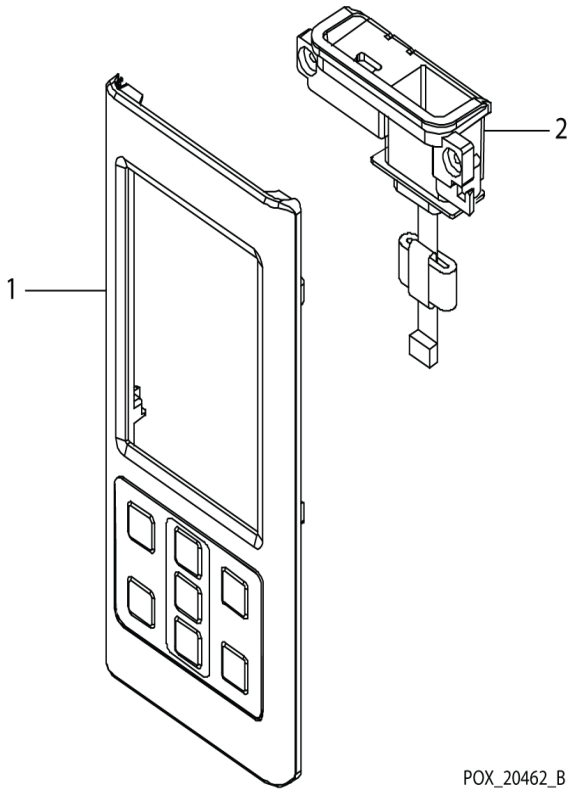
4. Complete the steps in *Replace the Batteries*, page 6-5.

6.5.6 PI Cable and Cable Housing Replacement

Remove the PI Cable and Cable Housing

1. Turn the monitoring system off.
2. Complete the steps in *Remove the Batteries*, page 6-5.
3. Complete the steps in *Disassemble the Front and Rear Assemblies*, page 6-7.
4. Move the rear assembly off to the side, retaining the front assembly (1) on a static-free working surface with the inside of the assembly facing up.
5. Carefully unlock the connector for the PI cable on the main board and disconnect the PI cable.
6. Pull the cable housing assembly, including the attached PI cable (2), straight up to remove the assembly from the front housing.

Figure 6-9. PI Cable and Cable Housing Replacement



Replace the PI Cable and Cable Housing

1. Place the front assembly on a static-free work surface with the inside of the assembly facing up.
2. Orient the cable housing and attached PI cable (2) so that the PI cable is on the left relative to the inside top of the front housing.
3. Press the cable housing in place in the rear housing.
4. Connect the PI cable to the main board and ensure that the connector on the main board is locked.
5. Complete the steps in *Reassemble the Front and Rear Assemblies*, page 6-8.
6. Complete the steps in *Replace the Batteries*, page 6-5.

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