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E SERIES®

Pulse Oximetry (SpO_2)

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PULSE OXIMETRY (SpO_2)

General Information

Product Description

The E Series® pulse oximeter (SpO_2) continuously and noninvasively measures the oxygen saturation of arteriolar hemoglobin at a peripheral measurement site, (i.e. foot, toe or finger). SpO_2 monitoring gives information about both the cardiac and respiratory systems, and provides details of oxygen transportation in the body. It is widely used because it is noninvasive, continuous, easily applied and painless.

The E Series pulse oximetry option is intended for use only with ZOLL / Masimo LNCS® sensors. The oximetry sensor contains two light-emitting diodes (LEDs) that transmit red and infrared light through the body's extremities. The transmitted light is then received by a photodetector.

Oxygen-saturated blood absorbs light differently than unsaturated blood. Thus the amount of red and infrared light absorbed by blood flowing through a suitable peripheral area of the body, typically the finger in adults and the foot in neonates, can be used to calculate the ratio of oxygenated hemoglobin to total hemoglobin in arterial blood. The monitor displays this ratio as percent SpO_2. Normal values typically range from 95% to 100% at sea level.

The quality of SpO_2 measurements depends on correct size and application of the sensor, adequate blood flow through the sensor site, and the sensor's exposure to ambient light. For correct placement and location of the sensors, refer to *Directions for Use* included with all LNCS oximetry sensor packages.

How to Use This Manual

This insert describes how to set up, use and maintain the pulse oximetry option on the E Series unit.

Important safety information relating to the general use of the E Series pulse oximeter appears in "Safety Considerations" on page 2 of this document. Other important safety information is located in the "Safety Considerations" section of the LNCS oximetry sensor packages. The *E Series Operator's Guide* provides the information that you need to know for the safe and effective use and care of the E Series products. It is important that you read and understand all the information contained therein before operating your E Series product.

Please thoroughly read both the safety consideration sections before operating your E Series product.

Safety Considerations

Warnings

General

- Before use, carefully read the *E Series Operator's Guide*, these operating instructions, and the *Directions for Use* included with each LNCS sensor.
- Only qualified personnel should operate the E Series Pulse Oximeter.
- Do not use the pulse oximeter as an apnea monitor.
- Do not immerse the E Series device, patient cables, or sensors in water, solvents, or cleaning solutions.
- Consider a pulse oximeter an early warning device. As a trend toward patient deoxygenation is indicated, blood samples should be analyzed by a laboratory co-oximeter to completely understand the patient's condition.
- If an alarm occurs while the audio alarms are suspended, the suspended alarm indications will only be visual displays and symbols.
- Interfering Substances: Carboxyhemoglobin and methemoglobin may erroneously alter SpO_2 readings. The level of change is approximately equal to the amount of carboxyhemoglobin or methemoglobin present. Dyes, or any substance containing dyes, that alter arterial pigmentation may cause erroneous readings.
- Do not use the E Series pulse oximeter or LNCS sensors during magnetic resonance imaging (MRI). Induced current could potentially cause burns. The E Series pulse oximeter may affect the MRI image, and the MRI unit may affect the accuracy of the oximetry measurements.
- Carefully route patient cabling to reduce the possibility of patient entanglement or strangulation.
- Functional testers cannot be used to assess the accuracy of the pulse oximeter.

Sensors

- Use only ZOLL / Masimo LNCS oximetry sensors for SpO_2 measurements. Other manufacturers' sensors may cause improper oximeter performance.
- Tissue damage can result from incorrect application or use of an LNCS sensor (for example, by wrapping the sensor too tightly). Inspect the sensor site as directed in *Directions for Use* (included with each LNCS sensor) to ensure skin integrity, correct positioning and sensor adhesion.
- Do not use damaged LNCS sensors or cables.
- Do not use an LNCS sensor with exposed optical components.
- Do not sterilize the sensor by irradiation, steam, or ethylene oxide. See the cleaning instructions included with each LNCS sensor.
- Do not allow the sensor to remain on one site for a prolonged period of time, especially when monitoring neonates. Check the application site at regular intervals - at least every two hours - and change the site if any compromise in skin quality occurs. Refer to the *Directions for Use* included with each LNCS sensor.
- Do not attach the SpO_2 sensor to a limb being monitored with a blood pressure cuff or with restricted blood flow.
- A poorly applied sensor may give incorrect saturation values. The signal strength indicator can be used to identify a poorly applied sensor or poorly chosen site.
- Choose a site with sufficient perfusion to ensure accurate oximetry values.
- Certain nail aberrations, nail polish, fungus, etc. may cause inaccurate oximetry readings. Remove the nail polish and/or move the sensor to an unaffected digit.
- High ambient light sources such as surgical lights (especially those with xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps, and direct sunlight can affect the accuracy of SpO_2 readings. To prevent interference from ambient light, ensure that the sensor is properly applied and cover the sensor with opaque material if required.

SpO_2 Indication for Use

The ZOLL E Series pulse oximeter, with Masimo SET technology and the LNCS series of sensors, is indicated for the continuous noninvasive monitoring of arterial oxygen saturation (SpO_2) and pulse rate. The pulse oximeter is indicated for use on adult, pediatric, and neonatal patients who are stationary or in motion in a hospital or prehospital environment.

Oxygen saturation measurements using pulse oximetry are highly dependent on proper placement of the sensor and patient conditions. Patient conditions such as smoke inhalation may result in erroneous oxygen saturation readings. If pulse oximetry measurements are suspect, verify the reading using another clinically accepted measurement method, such as arterial blood gas measurements.

Measurement Complications

If the accuracy of any reading is suspect, first check the patient's vital signs by alternate means and then check the E Series pulse oximeter for proper functioning.

Inaccurate measurements may be caused by:

- Incorrect sensor application or use.
- Significant levels of dysfunctional hemoglobins (e.g., carboxyhemoglobin or methemoglobin).
- Intravascular dyes such as indocyanine green or methylene blue.
- Exposure to excessive illumination, such as surgical lamps (especially those with a xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps, or direct sunlight; exposure to excessive illumination can be corrected by covering the sensor with a dark or opaque material.
- Excessive patient movement.
- Venous pulsations.
- Placement of a sensor on an extremity with a blood pressure cuff, arterial catheter, or intravascular line.

Loss of pulse signal can occur when:

- The sensor is applied too tightly.
- There is excessive illumination from light sources such as a surgical lamp, a bilirubin lamp, or sunlight.
- A blood pressure cuff is inflated on the same extremity as the one with a SpO_2 sensor attached.
- There is excessive patient movement.
- The patient has hypotension, severe vasoconstriction, or hypothermia.
- There is arterial occlusion proximal to the sensor.
- The patient is in cardiac arrest or shock.

SpO_2 Connector and Sensors

The SpO_2 connector is located on the rear panel of the E Series unit (see Figure 1). You can use only ZOLL or Masimo accessories and sensors with the E Series Pulse Oximetry option.

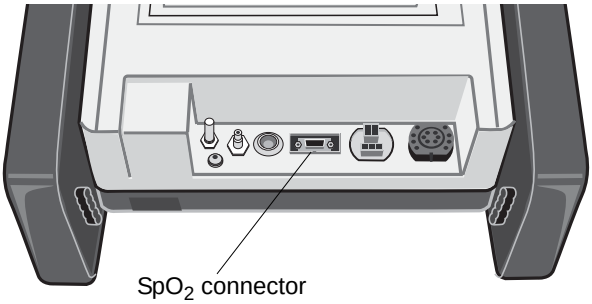


Figure 1

Each sensor is designed for application to a specific anatomical site on patients within a certain weight range.

To ensure optimal performance:

- Use an appropriate sensor.
- Apply the sensor as described in *Directions for Use* included with each LNCS sensor.

Tissue damage can result from incorrect application or use of a sensor (e.g., wrapping the sensor too tightly, applying supplemental tape, failing to periodically inspect the sensor site).

SpO_2 Setup

Set up the SpO_2 option as follows:

1. Inspect the E Series case and SpO_2 cables for damage.
2. Ensure that the sensor and cable are compatible models before connecting it to the E Series unit (see “SpO2 Accessories” on page 9).
3. Attach the sensor to the patient and connect the sensor to the SpO_2 patient cable (see “Applying a Reusable DCI Sensor” on page 4 or “Applying a Disposable Sensor” on page 5).

   If using a reusable sensor, make sure it opens and closes smoothly and check for foreign material such as tape or cotton on the emitter and detector windows. Remove any substances that may interfere with the transmission of light between the sensor's light source and detector.
4. Connect the patient cable to the SpO_2 connector at the back of the E Series unit (see Figure 2).

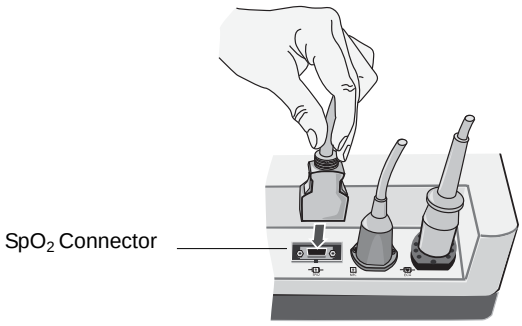


Figure 2

5. Turn the selector switch to MONITOR (ON for AED units).

   The SpO_2 parameter box will appear momentarily on the screen.

6. Verify that the sensor's red LED is on. The oximeter is now fully operational.

   A dashed line is displayed in the SpO_2 field until a pulse is detected. Once the measurement has been established, the saturation values are displayed in the numeric field (e.g., 98).

7. Ensure that appropriate oxygen saturation values are displayed and that the signal strength bar indicates the presence of a strong signal associated with each heartbeat.

8. Adjust the alarm limits and enable SpO_2 alarms if desired.

Note: If ECG leads are not attached, the patient's pulse rate as measured by the SpO_2 sensor is displayed as the Heart Rate (HR) in the ECG field and the heart symbol does not flash.

If the unit displays a *SPO2 FAULT XX* message shortly after power-up, the SpO_2 monitoring subsystem of the unit has failed. Contact the ZOLL Technical Service Department.

Selecting a Sensor and Patient Cable

When selecting a sensor, consider the patient's weight, the adequacy of perfusion, the available sensor sites, and the anticipated duration of monitoring. For more information, refer to the following table or contact ZOLL Medical Corporation.

Sensor	Type	Patient Weight
LNCS Adtx	Single Use	Adults > 30 kg
LNCS Pdtx	Single Use	Pediatrics and Slender Adults 10 - 50 kg
LNCS Neo-L	Single Use	Neonates < 3 kg
LNCS NeoPt-L	Single Use	Neonates < 1 kg
LNCS Inf-L	Single Use	Infant 3 - 20 kg
LNCS DCI	Reusable	Adults and Pediatrics > 30 kg
LNCS DCIP	Reusable	Pediatrics 10 - 50 kg

ZOLL offers two reusable patient cables designed to work exclusively with LNCS sensors and with the E Series pulse oximeter:

- LNC-4 (4’ cable)
- LNC-10 (10’ cable)

Selecting a Sensor Application Site

Choose a site that is well perfused and restricts a conscious patient's movements the least. The ring finger or middle finger of the nondominant hand is preferred.

Alternatively, you can use the other digits on the nondominant hand. Be sure the sensor's detector is fully covered by flesh. You can use the great toe or long toe (next to the great toe) on restrained patients or patients whose hands are unavailable.

To prevent interference from ambient light, ensure that the sensor is properly applied, and cover the sensor site with opaque material, if required. Failure to take this precaution in high ambient light conditions may result in inaccurate measurements.

Applying a Reusable DCI Sensor

Note: These instructions describe how to apply a reusable DCI sensor. For all other reusable sensors, refer to the sensor packaging for application instructions.

Note: The reusable sensor is not intended for use on the thumb or across a child's hand or foot.

1. Place the selected digit over the sensor window of the reusable DCI sensor, making sure that the sensor cable runs over the top of the patient's hand.

   The fleshiest part of the digit should cover the detector window in the lower half of the DCI sensor (see Figure 3).

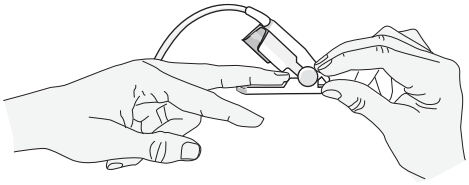


Figure 3

2. On finger sites, make sure the tip of the finger touches or extends beyond the raised digit stop inside the DCI sensor (see Figure 4).

Figure 4

Note: With smaller digits, the digit may not need to be pushed all the way to the stop to completely cover the detector window.

3. Check the sensor position to ensure that the top and bottom halves of the DCI sensor are parallel. To ensure accurate data, you must have complete coverage of the detector window (see Figure 4).
4. Lift the clear plastic protective cover from the female end of the patient cable, then plug the sensor cable's male connector all the way into the patient cable connector (see Figure 5).

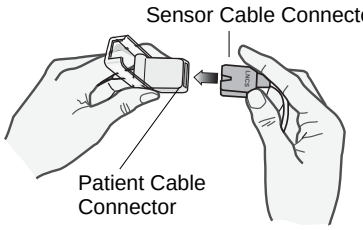


Figure 5

5. Lower the clear plastic protective cover over the connection to secure it (see Figure 6).

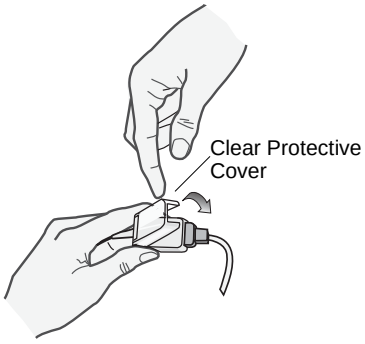


Figure 6

6. Connect the SpO_2 patient cable to the SpO_2 connector on the back of the E Series unit as shown in Figure 2 on page 4.

Applying a Disposable Sensor

You can use a disposable LNCS sensor for SpO_2 monitoring. Do not wrap the adhesive too tightly as this can cause venous pulsations that could lead to inaccurate saturation measurements.

You can reapply a disposable sensor to the same patient if the emitter and detector windows are clear and the adhesive still adheres to the skin.

You can partially rejuvenate the adhesive by wiping it with an alcohol wipe and allowing the sensor to thoroughly air dry prior to replacement on the patient.

Note: LNCS Adtx sensors are not intended for use across a child's hand or foot. For instructions on proper application of neonatal sensors, refer to the *Directions for Use* included with each LNCS sensor.

1. Open the pouch, and remove the sensor.
2. Holding the sensor with the tan printed side downward, bend the sensor backward and remove backing material from the sensor.
3. Orient the sensor so that the digit can be attached to the detector side of the sensor first (see Figure 7).

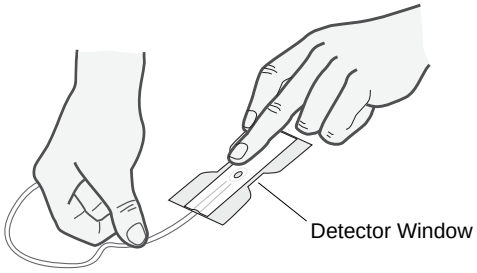


Figure 7

4. Press the detector onto the fleshy part of the finger near the tip of the finger. To ensure accurate data, you must have complete coverage of the detector window.
5. With the emitter positioned over the fingernail, secure the wings around the finger (see Figure 8).

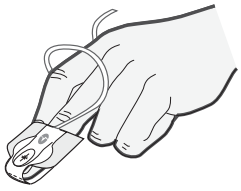


Figure 8

When positioned properly, the:

- emitter and detector are vertically aligned
- digit completely covers the detector window
- connector tab is located on the top side of the finger

6. Lift the clear plastic protective cover from the female end of the patient cable, then plug the sensor cable's male connector all the way into the patient cable connector (see Figure 5).
7. Lower the clear plastic protective cover over the connection to secure it (see Figure 6).

8. Connect the SpO_2 patient cable to the SpO_2 connector on the back of the E Series unit as shown in Figure 2 on page 4.

Ensuring Accurate SpO_2 Monitoring

The following points aid in ensuring oximetry monitoring success:

- Choose a site that is well perfused and allows for proper alignment of the light emitter and detector.
- Select a site that has unrestricted blood flow.
- Ensure that blood flow is not restricted when securing a sensor with tape.
- Select a site which is not near potential sources of electrical interference (electrical cords, for example).
- Use only sensors which show no obvious damage or exposed electrical circuits.
- Ensure that the sensor site is not subject to excessive motion. Excessive motion may adversely affect the performance of the sensor.
- Inspect the SpO_2 sensor site at least once every two (2) hours to ensure adhesion, skin integrity, and correct alignment of the light emitter and detector. Should alterations of skin integrity occur, remove the sensor and reapply at another recommended site. Avoid application of the sensor to edematous or fragile tissue.
- Remove and reposition the sensor every eight (8) hours and, if indicated by circulatory condition or skin integrity, reapply to a different monitoring site.
- Avoid creating venous pulsations caused by overly tight adhesive or by using additional tape to secure the sensor. Venous pulsations could potentially lead to inaccurate saturation measurements.
- Reposition the sensor or choose a different monitoring site if the sensor fails to track the pulse consistently, as the sensors may be incorrectly positioned.
- Ensure that the signal strength bar graph indicates the presence of a strong signal associated with each heart beat.
- Avoid placing the SpO_2 sensor on any extremity with an arterial catheter, blood pressure cuff, or intravascular line.

Cleaning and Reuse of Sensors

Reusable sensors can be cleaned as follows:

1. Disconnect the sensor from the patient cable.
2. Wipe the entire sensor clean with a 70% isopropyl alcohol moistened pad.
3. Allow the sensor to air dry before returning it to use.

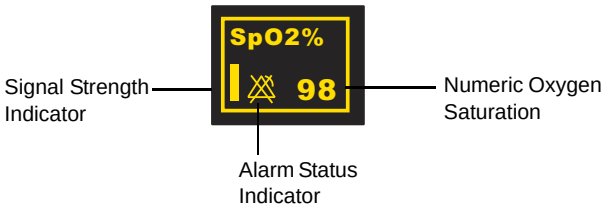
Cleaning and Reuse of Patient Cables

Patient cables can be cleaned as follows:

1. Disconnect the sensor from the patient cable (if attached).
2. Disconnect the cable from the rear of the E Series unit.
3. Wipe the cable clean with a 70% isopropyl alcohol moistened pad.
4. Allow the cable to dry before using it.

How SpO_2 is Displayed

The pulse oximetry option displays a plethysmograph waveform derived from data supplied by the sensor. The oxygen saturation value is displayed as “SpO2%”. A signal strength indicator, left of the SpO_2 field, shows the relative change in the pulsatile signal (see below).



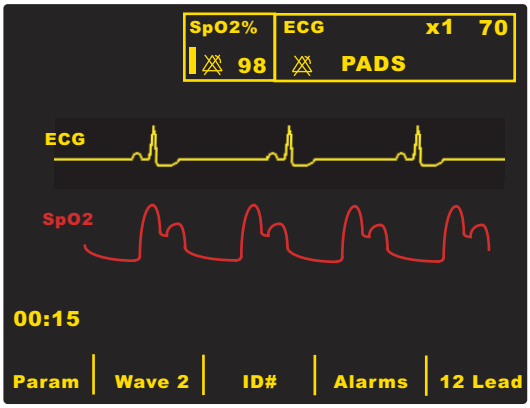
Note: The SpO_2 numeric displays dashes (-----) in the oxygen saturation field whenever pulse oximetry values are likely to be contaminated due to the presence of excessive ambient light, inadequate perfusion, high signal artifact, a defective or disconnected sensor, etc.

Displaying the Plethysmographic Waveform

The E Series unit can display one or two waveforms in MONITOR, DEFIB, or MANUAL (AED) mode, as long as the defibrillator is not charging or ECG analysis is not in progress. The unit displays only one waveform in PACER mode.

With SpO_2 monitoring, the unit can display a normalized plethysmographic waveform below the ECG trace for a visual indicator of SpO_2 monitoring.

From the physiological monitoring menu, press the **Wave 2** softkey to cycle the display from the capnogram waveform, to the plethysmograph waveform, to no second waveform displayed.



The unit temporarily removes the second waveform from the display when you press the **CHARGE**, **ANALYZE**, or **ENERGY SELECT** buttons, or the **Sync On/Off** softkey. The unit restores the second waveform to the display 4 seconds after:

- A shock is delivered.
- A shockable rhythm analysis is completed, unless the defibrillator is charging.
- **ENERGY SELECT** button is pressed.
- Sync mode is turned off.

Physiological Monitoring

When you turn the E Series unit to MONITOR (ON for AED units), the physiological monitoring menu is displayed with the following softkeys: **Param**, **Wave 2**, **ID#**, **Alarms** and **12 Lead** (if installed).

Param Softkey

When the **Param** softkey is pressed, the following softkeys appear: **Select**, **Enter**, and **Return**.

Press the **Select** softkey to scroll the highlight area among the different available physiological parameters.

Press the **Enter** softkey to select the highlighted parameter.

Press the **Return** softkey to return to the physiological monitoring menu.

When you select the SpO_2 parameter, the following softkeys appear: **Sens.**, **Average**, **Alarms** and **Return**.

Sens. (Sensitivity) Softkey

The **Sens.** softkey allows you to select either Normal or High sensitivity for SpO_2 monitoring.

- The Normal sensitivity setting is the recommended setting; select it for most patients.
- The High sensitivity setting allows you to monitor SpO_2 even under very low perfusion conditions. Such conditions may include severe hypotension or shock. With the High sensitivity setting, however, SpO_2 results are more easily contaminated by artifact. To ensure accuracy of SpO_2 readings when using the High sensitivity setting, observe the patient carefully and continuously.

To select the sensitivity mode, press the **Sens.** softkey to toggle between the modes, then press the **Enter** softkey to select the highlighted mode.

Press the **Return** softkey to return to the SpO_2 submenu.

Average Softkey

The E Series provides 3 different time periods over which SpO_2 values are averaged: 4 seconds, 8 seconds (default), and 16 seconds.

The averaging period is rarely changed from the 8 second default setting. For high risk patients with rapidly changing SpO_2 conditions, use the 4 second setting. Use the 16 second setting only when the 8 second setting (default) is inadequate due to extremely high artifact conditions.

To select the averaging period (4, 8, or 16 seconds), first press the **Average** softkey on the SpO_2 submenu. The following softkeys appear: **Average**, **Enter** and **Return**.

Press the **Average** softkey again to scroll through the different averaging periods, then press the **Enter** softkey to select the highlighted averaging period. Press the **Return** softkey to return to the SpO_2 submenu.

Alarms

The E Series SpO_2 option provides user programmable "out of range" alarms for both SpO_2 and heart rate. See "Default Settings" on page 9 for low and high alarm limit default values and ranges.

Once the SpO_2 value reaches the high or low limit, there is a 4 second delay before the alarm occurs.

When monitoring a patient's heart rate using ECG, the high heart rate alarm limit range is 60 to 280 bpm, with a default setting of 150 bpm. When monitoring the heart rate using pulse oximetry, however, the maximum high heart rate alarm limit is automatically lowered to 235 bpm if it was previously set higher for ECG monitoring. The unit restores the original high heart rate alarm limit setting when ECG monitoring resumes.

When the SpO_2 alarm state is set to AUTO, the unit automatically sets the alarm limits to 95% and 105% of the patient's currently measured saturation (the maximum setting being 100%). The auto alarm limits are set only if valid measurements are present for the vital sign.

See the *E Series Operator's Guide* for details on enabling, disabling, and suspending alarm functions on the E Series unit.

Automated External Defibrillator (AED) Operation

E Series AED units equipped with pulse oximetry operate in a slightly different way when in Semi-Automatic Mode:

- The plethysmographic waveform cannot be displayed.
- Heart rate alarm functions are disabled (although SpO_2 alarm functions are operational). Background ECG analysis functions continue to operate as described in the AED section of the *E Series Operator's Guide*.
- You cannot change alarm limit settings; only the default alarm limits are available.

Checkout Procedure

Perform the following checkout procedure daily to ensure that the SpO_2 option is functioning properly. Use a reusable SpO_2 sensor when performing this procedure.

1. Attach the SpO_2 sensor to your finger and connect the SpO_2 patient cable to the SpO_2 connector at the back of the E Series unit (as described in "Applying a Reusable DCI Sensor" on page 4).
2. Turn the selector switch to MONITOR (ON for AED units, then select Manual mode).
3. With alarms enabled, verify that the patient alarms are functional by adjusting the high and low limits until the unit:
   - Emits a continuous audio tone.
   - Highlights the alarming parameter's value and flashes the alarm symbol on the display.
4. Disconnect the ECG cable and verify that your pulse rate is equal to the rate that appears on the E Series heart rate display.
5. Verify the sensor alarms are functional by unplugging the sensor from the E Series unit. Make sure the unit:
   - Displays the *CHECK SPO2 SENSOR* message.
   - Emits a two-beep audio tone.
6. Verify the plethysmographic waveform display by pressing the **Wave 2** softkey and ensuring that the waveform repeats at your pulse rate.

Default Settings

When the pulse oximeter is turned on, the following default settings are automatically selected and remain in operation until changed.

Parameter	Default Setting	Range
Averaging Mode	8 seconds (medium)	4 seconds (short) 8 seconds (medium) 16 seconds (long)
Sensitivity	Normal	Normal or High
High SpO_2 Alarm Limit	OFF (appears as: ---)	50% to 100% or OFF
Low SpO_2 Alarm Limit	85%	50% to 100% or OFF
High Heart Rate Alarm Limit	150 bpm (beats/minute)	60 to 280 bpm (beats/minute) - monitoring via ECG 60 to 235 bpm (beats/minute) - monitoring via Pulse Oximetry
Low Heart Rate Alarm Limit	30 bpm (beats/minute)	20 to 100 bpm (beats/minute)

Note: Only the default settings are available in AED Semi-Automatic operation. Default alarm limit setting may be adjusted in System Configuration mode. See the *E Series Configuration Guide* for more information.

SpO_2 Accessories

The following table describes each of the SpO_2 accessories.

Item	Description	REF
LNCS Adtx	Single use sensor for patients > 30 kg	8000-0320
LNCS Pdtx	Single use sensor for Pediatrics and Slender Adults 10 - 50 kg	8000-0321
LNCS Inf-L	Single use sensor for Infants 3 - 20 kg	8000-0322
LNCS Neo-L	Single use sensor for Neonates < 3 kg	8000-0323
LNCS NeoPt-L	Single use sensor for Neonates < 1 kg (Pre-term)	8000-0324
LNCS DCI	Reusable sensor for Adults and Pediatrics > 30 kg	8000-0294
LNCS DCIP	Reusable sensor for Pediatrics 10 - 50 kg	8000-0295
LNC-4	4' Reusable Patient Cable	8000-0298
LNC-10	10’ Reusable Patient Cable	8000-0293
LNC Ext	LNC Extension Cable, DB-9 Termination, 4ft	8000-0325
LNCS-to-LNOP	Adapter Cable, LNCS Sensor to LNOP Patient Cable	8000-0327
LNOP DC-12	LNOP Adult Reusable Direct Connect 12’ Cable	8000-0296

Note: LNOP single use and reusable sensors are no longer available, but remain compatible with the E Series.

Messages and Troubleshooting

The following table lists the error messages associated with the SpO_2 option, and the corresponding corrective action(s). Read this section carefully before using the oximeter for patient monitoring.

Message	**Possible Cause(s)**	**Recommended Action(s)**
CHECK SPO2 SENSOR	The SpO_2 readings may be invalid due to excessive motion, inappropriate sensor site, poor placement, low perfusion, or sensor is not attached.	For all causes, reposition or relocate the sensor and/or increase perfusion.
CHECK SPO2 SITE	Low perfusion or low signal strength.	Reposition or relocate the sensor.
SPO2 AMBIENT LIGHT/ CHECK SPO2 SENSOR	Excessive ambient light.	Relocate the sensor to a site shielded from light or reduce the amount of light shining on the sensor.
SPO2 FAULT XX	The SpO_2 subsystem of the unit has failed.	Call ZOLL Technical Service Department.
SPO2 PULSE SEARCH	The oximeter cannot detect a patient's pulse.	Reposition or relocate the sensor and/or increase perfusion.
Dashes (-----) appear in place of SPO2 numeric and do not change to a real number.	Excessive ambient light, inadequate perfusion, high signal artifact, a defective or disconnected sensor, etc.	Reposition or relocate the sensor and/or increase perfusion.

Specifications

General	
Saturation (% SpO_2) Range	1% - 100%
Pulse Rate (bpm) Range	25 - 240 bpm (beats per minute)
Saturation (% SpO_2) Accuracy During No Motion Conditions	Adults/Pediatrics 70% - 100%, ±2 digits 0% - 69%, unspecified Neonates 70% - 100%, ±3 digits 0% - 69%, unspecified
Saturation (% SpO_2) Accuracy During Motion Conditions	Adults/Pediatrics/Neonates 70% - 100%, ±3 digits 0% - 69%, unspecified
Pulse Rate (bpm) Accuracy During No Motion Conditions	±3 bpm
Pulse Rate (bpm) Accuracy During Motion Conditions	±5 bpm
SpO_2 Alarm Limits	On/Off displayed on monitor. User selectable. High 72 - 100% saturation, Low 70 - 98% saturation
SpO_2 Wavelength	Nominal Red LED Wavelength: 660 nanometers Nominal Infrared LED Wavelength: 905 nanometers
Energies (Radiant Power) of light for LNCS Sensors at 50 mA pulsed	Minimum: 0.13 mW Maximum: 0.79 mW
Saturation (% SpO_2) Resolution	1%
Pulse Rate Alarm Limits	On/Off displayed on monitor. User selectable. High 60 - 235 beats per minute, Low 20 - 100 beats per minute
Pulse Rate Resolution	1 bpm (beats per minute)
Bio-Compatibility	Patient contacting material meets requirements of ISO 10993-1, Biological Evaluation of Medical Device - Part I, for external devices, intact surfaces and short-term exposure
Environmental	Operating Temperature: 0º to 40º C (32º to 104º F) Storage Temperature: -40º to 70º C (-40º to 158º F) **Note:** The E Series device may not perform to specifications when stored at the upper or lower extreme limits of storage temperature and immediately put into use

Electromagnetic Immunity (SpO_2 Option Only)	AAMI DF-80; EN61000-4-3:2002 to 10 V/m	
Operating Time	For a new, fully charged PD4410 battery pack at 20°C (68°F): • 35 defibrillator discharges at maximum energy (200 J), or • 2.0 hours minimum of continuous ECG monitoring, or • 1.75 hours of continuous ECG monitoring/pacing at 60 mA, 70 beats per minute.	For a new, fully charged lithium ion battery pack at 20°C (68°F): • 95 defibrillator discharges at maximum energy (200 J), or • 3.75 hours minimum of continuous ECG monitoring, or • 3.25 hours of continuous ECG monitoring/pacing at 60 mA, 70 beats per minute.

Note: The E Series Pulse Oximetry Option is calibrated for functional saturation.

Note: Because the E Series pulse oximeter measurements are statistically distributed, only about 68% of these measurements can be expected to fall within ±1 standard deviation of the value measured by a co-oximeter.