Tech Note

PO2-100D Pulse Oximeter and Plethysmography Sensor

Overview

One of the best methods for monitoring the cardio-pulmonary condition of a patient in a hospital or an athlete in training is the measurement of the subject's blood gases, oxygen and carbon dioxide. The process is invasive and requires the use of an expensive device known as a blood gas analyzer. An alternate method of determining the amount of oxygen in blood is pulse oximetry. This method is easy and non-invasive, and can be performed with a simple device like the PO2-100D Pulse Oximeter (Figure 1) that has a sensor that clips over the end of the subject's finger or toe.

How It Works

The PO2-100D Pulse Oximeter measures the amount of oxygen in blood indirectly by determining the oxygen saturation level (SpO2) of the hemoglobin in blood. Hemoglobin exists in the blood in two different forms, oxygenated (oxyhemoglobin) and deoxygenated (deoxyhemoglobin). Oxygenated hemoglobin absorbs more infrared light and allows more red light to pass; where as, deoxygenated hemoglobin absorbs more red light and allows more infrared light to pass. Therefore, the absorbance of each wavelength of light depends on the saturation or desaturation of hemoglobin, and can be used to determine the oxygen saturation level of the hemoglobin.

Figure 1: PO2-100D Pulse Oximeter and Plethysmography Sensor

The sensor of the PO2-100D emits wavelengths of light at 600nm (Red) and 925nm (Infrared), and then detects the absorbance of those wavelengths by the hemoglobin in the blood. Through the programming built into the PO2-100D, the absorbance of light at each wavelength is used to determine the ratio between the concentrations of oxygenated and deoxygenated hemoglobin in the blood. After conversion of the output of the PO2-100D to the proper units, the level of oxygen in the blood is expressed as the percentage of oxygen saturation. Normally, the oxygen saturation level of blood is between 95 and 100%.

Equipment Setup

1. Plug one end of the male DIN-DIN cable into the DIN8 connector of the PO2-100D oximeter. Plug the other end of the same cable into the Channel 3 input of the iWorx 214 recorder (Figure 2).
2. Connect one end of a BNC-BNC cable to the BNC output of the PO2-100D and the other end of the BNC-BNC cable to the BNC input of Channel 2 on the iWorx 214 recorder (Figure 2).
3. Clip the sensor over the end of the subject's middle or ring finger. An embossed diagram on the sensor indicates the position of the finger within the clip. The indicator light on pulse oximeter will stop blinking in a few seconds when the sensor is positioned and working properly.

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Figure 2: The PO2-100D Pulse Oximeter connected to Channels 2 and 3 of an IX/214 data acquisition unit.

Warnings

The PO2-100D sensor will not work properly when placed over fingernails coated with any shade of nail polish, or over artificial nails. Also, make sure the center of the nail is aligned under the light emitting diode of the sensor when the clip is placed on the finger or toe.

Units Conversion

The output of the PO2-100D Pulse Oximeter is a voltage that can be converted to a percentage. If the output is recorded using an iWorx data acquisition unit and LabScribe software, the output can be converted from voltage to the percentage of oxygen saturation in the blood using the following steps:

1. Make sure the sensor is placed on the subject's finger correctly. The indicator light of the pulse oximeter will stop blinking after a few seconds when the unit is working properly.

2. Click on the **Start** button in the upper right corner of the LabScribe Main window. Record from the subject for about ten seconds. Click on the **Stop** button. Two blue cursors should appear on the Main window.

3. Right-click on the recording area of the Oxygen Saturation channel to open that channel's right-click menu. Select **Units** from the menu and **Simple** from the submenu to open the Units Conversion dialogue window.

4. Pull down the menu in the upper left corner of the Units Conversion dialogue window and select **slope & offset**. Set the **slope** equal to **10**, the **offset** equal to **80**, and the **Name** of the units for the Y-axis equal to **%O2** Sat. Put a check in the box next to **Apply Units to All Blocks**. Click on the **OK** button.

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Heart Rate Measurements

Since the sensor of the PO2-100D also functions as a pulse plethysmograph, the pulse signal can be used to determine the subject's heart rate. If the PO2-100D is used with an iWorx data acquisition unit and LabScribe software, the pulse signal can be used to compute and display the subject's heart rate on another channel:

1. On the LabScribe Main window, open the **Edit** menu and select **Preferences** from the menu. The Preferences dialogue window will open onto the Channels page.

2. If an unused channel is available, click on the title of the channel, and change the title of the channel to **Heart Rate**. If an unused channel is not available, increase the number of channels displayed by changing the number in the box next to the label **Num Channels**. Click the **OK** button at the bottom of the window to return to the Main window.

3. Right-click on the recording area of the new Heart Rate channel to open the channel's right-click menu. Select **Periodic** from the menu and **Rate** from the submenu.

4. Right-click on the recording area of the Heart Rate channel to open the channel's right-click menu, for a second time. Select **Set Raw Ch** from the menu and the **Pulse** channel from the submenu.

5. While recording the pulse, heart rate, and oxygen saturation data, click on the **AutoScale** button for the Pulse channel; then, click on the **AutoScale** button for the Heart Rate channel to display the subject's heart rate.

Experiments

Experiments using the PO2-100D Pulse Oximeter can be downloaded by clicking on the following links:

Print-disabled Oxygen Saturation Levels and Ventilation Experiment (PDF file).

User Area (password protected)
High resolution press optimized Oxygen Saturation Levels and Ventilation Experiment (PDF file).
Low resolution screen optimized Oxygen Saturation Levels and Ventilation Experiment (PDF file).

Accuracy

Oxygen saturation (SpO2) data is valid across a pulse rate range from 18 to 300 beats per minute. SpO2 data is reported on a beat-to-beat basis with a maximum update rate of three data points per second.

Operation and Storage Environment

The device is designed to operate in a 0 to 50^{O}C environment with 10-90% non-condensing humidity. The device may be stored in an environment from -30 to 50oC with 10-95% non-condensing humidity.

Safety

The sensor meets IEC 60601-1 Dielectric Withstand specification.

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