



Respiration Rate Sensor

PS-2133



Sensor Specifications

Sensor Range:	0 to 10 kPa
Resolution:	0.001 kPa
Accuracy:	± 0.5 kPa
Repeatability:	0.01 kPa
Maximum Sample Rate:	20 samples per second
Operating Temperature:	0–40°C
Relative Humidity Range:	5–95%, non-condensing*

The specifications apply to the PS-2114 Relative Pressure Sensor, which is part of the Respiration Rate Sensor.

*Note: Condensation on the sensor may reduce the sensor's measurement accuracy.

Respiration Quick Start

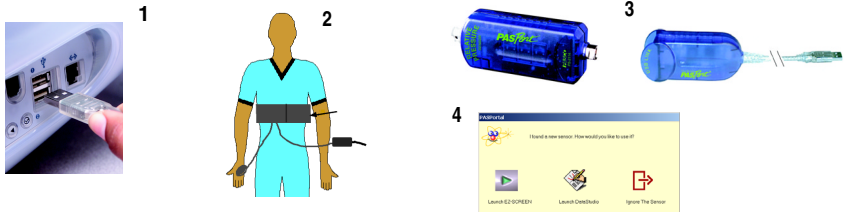
The PS-2133 Respiration Rate Sensor measures breath rate in one-minute cycles. The Respiration Rate Sensor includes a Relative Pressure Sensor and inflatable belt, which wraps around the chest. As the person breathes, respiration rate and pressure changes can be displayed in a graph on a computer.

Additional Equipment Needed

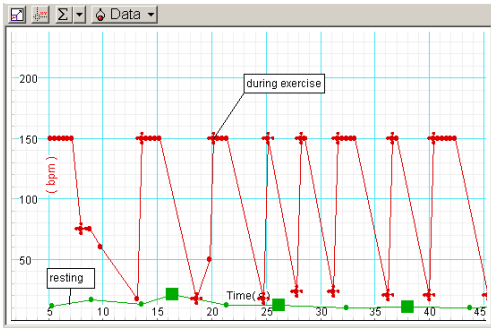
- PASPORT™ USB interface (USB Link (PS-2100) with USB-compatible computer or a PS-2000 Xplorer)
- DataStudio® software, version 1.8 or later

Equipment Setup

1. Connect the USB Link to a USB port on your computer or to a USB hub. (If using the Xplorer as an interface in the classroom, connect the Xplorer cable to the USB port on your computer.)
2. Wrap the Respiration belt below your rib cage and connect the Respiration Belt tubing to the Relative Pressure Sensor. (See card 2A for proper instructions and safety information.)
3. Connect the Relative Pressure Sensor to the USB Link.
4. The software launches when it detects a PASPORT™ sensor. Select a point of entry.



Respiratory Rate: Resting vs. Exercise



DataStudio/DS Lite Tasks:	
Create an equation for measuring respiration rate in DataStudio:*	Click on the Calculator () button to open the Calculator dialog. Click the New () button. Type in respiration rate=60/period (30,30,5 relative pressure).**
Record the respiration rate and/or waveform:	From the Data list, drag the respiration equation and Relative Pressure icon to a display.*

*In the respiration activity, the respiration equation is already created for you.

Use the **Special button and menu to select the period function and replace the (10,10, x) values with (30,30,5). Under Variables, click on Data Measurement; then click on Relative Pressure and OK. Click the **Accept** button to accept the equation.

Respiration Activity

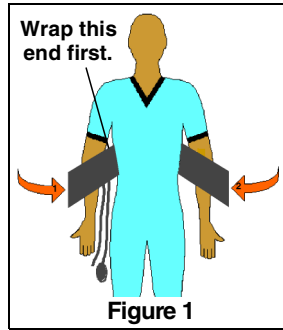
1. Wrap the respiration belt around your rib cage. (Follow the instructions for "Wearing the Respiration Belt" on card 2A.)
2. Use the quick-release connector on the end of the belt's tubing to connect the belt to the Relative Pressure Sensor.
3. Connect the Pressure Sensor to a PASPORT interface.
4. When the PASPORTAL window opens, select the Respiration workbook or configuration file. [Note: If you don't have version 1.8 of DataStudio, launch DataStudio, create an experiment, and follow the instructions in the table to the left for creating the respiration rate equation.]
5. Ensure the valve to the squeeze bulb is closed. Inflate the belt until the belt fits snugly against your chest. (Do not overinflate! Please read the safety warning and instructions on card 2A.)
6. On page 4 of the workbook, click the **Start** () button to record the respiration rate. Collect respiration rate data with (a) the student sitting, standing, and lying down and (b) before and after exercise.
7. (Optional): Remove the belt. Collect pressure data with the student breathing through a plastic tube connected to the Pressure Sensor. (See card 2B).
8. **Analysis:** Compare the change in respiration rate with different body positions and before and after exercise. Examine pressure changes for inspiration and expiration.

Other Experiment Suggestions

- Respiration rate vs. heart rate
- Respiration rate and body temperature (cold vs. hot environments)
- Respiration rate and pressure changes with different types of exercise (aerobic, weight lifting, etc.)
- Respiration rate and pressure changes (breathing vs. breath holding vs. forced expiration)
- Respiration rate at sea level vs. altitude

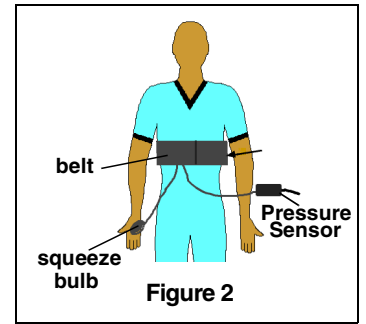
Wearing the Respiration Belt

1. Wrap the right portion of the belt (the side with the tubes) around your chest (the lower part of your rib cage). The hook-and-stick strips should face away from your chest.
2. Wrap the left half of the belt over the right part, so that the hook-and-stick strips stick to each other. The belt needs to fit snugly around the rib cage, but not so tight that breathing becomes restricted (See Figures 1 and 2).



Collecting Respiration Data

1. Wrap the respiration belt around the lower part of your chest.
 2. Push the quick-release connector on the tubing of the Respiration Belt into the port of the Relative Pressure Sensor. Turn the connector clockwise until it clicks into place.
 3. Connect the pin connector on the Relative Pressure Sensor to the interface (i.e. USB Link, etc.).
- [Note: The Xplorer can be used for collecting pressure data, but not respiration rate data. (For pressure studies, see the reverse side of this card.)]



4. On the squeeze bulb, turn the knob fully clockwise to close the valve.
5. Squeeze the bulb 10-20 times to inflate the rubber bladder. (**WARNING: Do not overflate!** Please see read the safety instructions on the left side of this card.) When the bladder is inflated, the belt will feel more snug against your chest.
6. In DataStudio, use the Calculator dialog to create an equation for the respiration rate (See detailed instructions on card 1B.)
7. To begin collecting data, click the **Start** button. To stop data collection, click the **Stop** button.
8. To deflate the belt, turn the knob on the squeeze belt counterclockwise to open the valve. Use your hands to push air out of the bladder. To disconnect the quick-release connector from the pressure port, turn it counterclockwise.

Belt Safety Instructions - Please Read!



WARNING: Do not inflate or wear the belt beyond an individual's comfort level. Overinflating the belt or wearing the belt too snugly could cause excessive pressure against the chest or abdominal cavities, etc., resulting in possible bodily injury or harm to internal organs.

Overinflation may also tear the bladder belt. When inflating the belt, squeeze the bulb slowly and allow adequate space for comfortable breathing to take place (at least one-finger width between the belt and body surface). If the belt is uncomfortable, unwrap the hook-and-stick straps and remove the belt. To deflate the bladder, turn the knob on the squeeze bulb counterclockwise to deflate the bladder. Before using the product, inform your students of the hazards of overinflating the belt and show students how to properly inflate, deflate, and remove the belt. PASCO cannot be held responsible for unsafe usage in the classroom.



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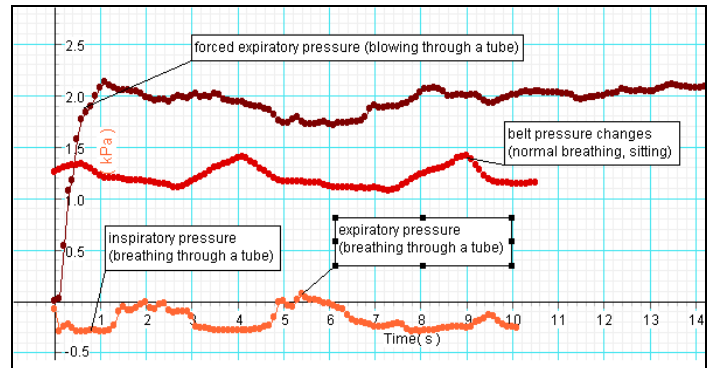
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Recording Lung Pressure Changes with the Respiratory Sensor

You can directly measure the inspiratory and expiratory pressures by having the students breathe through a plastic tube (using the tubing and connectors provided) connected to the Relative Pressure Sensor. Remove the Pressure Sensor from the belt, connect it to the plastic tubing, and have a student breathe through the tube. The lung pressure (in the *alveoli*, the air-filled sacs in the lungs) normally drops about 1 mm Hg during inspiration and rises about 1 mm Hg during normal expiration. (**WARNING:** Sucking directly from the tube is not recommended, because it would create a vacuum effect in the sensor. *Also, as a health precaution, always remember to wash and/or disinfect the tubing and connectors before and after use or between students.*)

Note: When the belt is connected to the Relative Pressure Sensor, the Pressure Sensor measures the pressure in the bladder of the belt as the lungs expand and contract. The pressure of the lungs and chest cavity expanding causes pressure against the bladder of the belt, but the pressure measured is not the actual pressure change in the lungs. (Any positive pressure change in the belt corresponds to a negative pressure change in the lungs and vice versa.)

Sample Pressure Data with the Respiratory Sensor



Respiration Sensor Usage Tips

1. Do not use the Pressure Sensor around liquids or beverages. Also, be careful not to get water or other liquids in the squeeze bulb, tubing, or bladder of the belt. Liquids will permanently damage the sensor and will also interfere with proper inflation of the bladder in the belt.
2. Before each data run, ensure that the valve to the squeeze bulb is completely closed. If the valve is left partially open, the release of air from the belt could skew data results.
3. To ensure measurement consistency, before each data run, check to ensure that the pressure in the belt is at the same baseline starting level.
4. When using the sensor with a PASPORT Xplorer, only pressure data will appear on the Xplorer display screen. Respiration rate data does not display on the Xplorer.

Pressure Changes During Respiration

The movement of the diaphragm facilitates respiration by changing the size of the chest cavity. During inspiration, the lungs expand with air, and the diaphragm moves down in the abdominal cavity, increasing the space and decreasing the pressure in the chest cavity (Figure 3). During expiration, the pressure in the lungs is higher than the atmospheric air pressure, and the lungs recoil to expel the air, while the diaphragm moves up toward the chest cavity.

