CO_2 Gas Sensor
(Order Code CO2-BTA)

The Vernier CO_2 Gas Sensor measures gaseous carbon dioxide levels by monitoring the amount of infrared radiation absorbed by carbon dioxide molecules.

The sensor has two ranges: Low (0–10,000 ppm) and High (0–100,000 ppm). The CO_2 Gas sensor is ideal for the following experiments:

- Measure the change in CO_2 gas concentration during cellular respiration.
- Measure the change in CO_2 gas concentration during photosynthesis.
- Study the effect of temperature on cell respiration or metabolism of organisms.
- Study how yeast metabolize different sugars.
- Investigate artificial selection by comparing respiration rates of different yeast strains.
- Human respiration under various conditions (at rest *vs*. after exercise)

Note: Vernier products are designed for educational use. Our products are not designed nor are they recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind.

What's Included

- CO_2 Gas Sensor
- 250 mL gas sampling bottle (Nalgene bottle with lid)

Compatible Software and Interfaces

See **www.vernier.com/manuals/co2-bta** for a list of interfaces and software compatible with the CO_2 Gas Sensor.

Getting Started

1. Connect the sensor to the interface (LabQuest Mini, LabQuest 3, etc.).
2. Start the appropriate data-collection software (Graphical Analysis, Logger *Pro*, LabQuest App) if not already running, and choose New from File menu.

The software will identify the sensor and load a default data-collection setup. You are now ready to collect data.

If you are collecting data using a Chromebook™, mobile device such as iPad® or Android™ tablet, or a Vernier wireless sensor or interface, please see the following link for up-to-date connection information:

www.vernier.com/start/co2-bta

Using the Product

1. Set the range switch on the sensor.
2. Connect the sensor following the steps in the Getting Started section of this user manual.

The following includes additional important information about the CO_2 Gas Sensor.

- Allow the CO_2 Gas Sensor to warm up for about 90 seconds before collecting data. During warmup, the readings may be very low.
- The CO_2 Gas Sensor is sensitive to high humidity. Do not use it in a condensing environment.
- Most experiments will use the Low range (0–10,000 ppm). The High range would be appropriate when measuring human respiration as expired air is typically 40,000–60,000 ppm CO_2.
- The CO_2 Gas Sensor is somewhat sensitive to temperature changes. In most cases, variations in CO_2 readings due to temperature changes are small (<100 ppm on Low range, <1000 ppm on High range). The sensor is designed to operate between 20 and 30°C. It can be used outside of this temperature range; however, the readings will be less accurate, even if you calibrate the sensor at the lower or higher temperature. With good experimental design, the variation in CO_2 readings due to a temperature change will be negligible compared to the overall change in CO_2 concentration. If an entire experiment is to be conducted at a constant temperature, you could improve the accuracy of the readings by calibrating the sensor at that temperature. Allow enough time for your CO_2 Gas Sensor to stabilize at the desired operating temperatures.
- The CO_2 Gas Sensor has a default sampling rate of 1 sample every 4 seconds. Faster sampling rates are not recommended. Gas must diffuse through the holes in the sensor tube before the sensor detects any changes in concentration. Because diffusion of gases is a slow process, there can be delays in the readings.
- To collect data in a controlled environment, it is recommended that you use the 250 mL gas sampling bottle that is included with your sensor.
- To collect data simultaneously with the CO_2 Gas Sensor and O_2 Gas Sensor, it is recommended that you purchase either the BioChamber 250 (250 mL capacity) or the BioChamber 2000 (2 L capacity). Each BioChamber has a second opening with a grommet so that you can insert two probes at once.
- Because the sensor operates using IR radiation, you should avoid placing the sensor in direct sunlight as much as possible during experiments. Even though the IR detector is shielded, it is best to avoid the possibility of reflected light affecting the readings by keeping the sensor in the shade when used outdoors.
- Best results are obtained when only one CO_2 Gas Sensor is connected to an interface at a time. The current draw from two or more CO_2 Gas Sensors connected to the same interface can cause erroneous data.

Videos
View videos related to this product at **www.vernier.com/co2-bta**

Calibration
You should not have to perform a new calibration very often when using the CO_2 Gas Sensor. A calibration is stored on the sensor before it is shipped. If you do find that you need to calibrate your CO_2 Gas Sensor, it can be done using a sample of outside air, which typically has a CO_2 gas concentration of about 400 ppm. Levels in your area may be slightly higher due to localized influences such as automobile or industrial emissions of carbon dioxide. **Note**: This calibration method is different from the usual two-point calibration performed with other Vernier sensors. To calibrate the CO_2 Gas Sensor:

1. Fill the gas sampling bottle (included with the sensor) to the brim with water, take it outside, and dump the water to ensure it is filled with fresh air. While still outdoors, insert the sensor into the gas sampling bottle containing fresh outside air. You can now take the bottle and sensor to the location where the calibration is to be done.
2. Connect the CO_2 Gas Sensor to the data-collection interface. Start the data-collection software and identify your interface, if necessary. Let the sensor warm up for at least 90 seconds.
3. When the CO_2 Gas Sensor has warmed up (readings should have stabilized), use a paper clip to press down the calibration button. Release the button as soon as the red light starts to blink. After about 30 seconds, the reading should stabilize at a value of approximately 400 ppm ±100 ppm in low range (or 400 ppm ±200 ppm in high range). If the reading is significantly lower or higher than 400 ppm, simply press the button again to repeat the process. **Note:** If the red light stays on solid, you have held the button too long. In this case, wait for it to go off and press it again, releasing as soon as it begins to flash.

Specifications

Measurement range of CO_2 Gas Sensor	Low range: 0 to 10,000 ppm CO_2 High range: 0 to 100,000 ppm CO_2
Low range typical accuracy (at standard pressure, 1 atm)	0 to 1,000 ppm ±100 ppm 1,000 to 10,000 ppm ±10% of reading
High range typical accuracy	0 to 100,000 ppm ±20% of reading
Response time	95% of full-scale reading in 120 seconds
Warm-up time	90 seconds
Pressure effect	0.19% of reading/mm of Hg from standard pressure
Output signal range	0 to 4.0 V
Input potential	5 V (±0.25 V)
Gas sampling mode	diffusion
Normal operating temperature range	25°C (±5°C)
Operating humidity range	5 to 95% (non-condensing)
Storage temperature range	–40 to 65°C

*For units purchased prior to 2007, see **www.vernier.com/til/3730**

Care and Maintenance
Very important: Do not expose the CO_2 Gas Sensor to any liquids, including water. The sensor is intended only for measuring gaseous, not aqueous, CO_2 concentration.

Temperatures greater than 65°C will damage the sensor.

It is recommended that you wash the gas sampling bottles by hand. Most dishwashers will melt the plastic.

How the Sensor Works
The Vernier CO_2 Gas Sensor measures gaseous carbon dioxide levels in the range of 0 to 10,000 ppm (Low range setting) or 0 to 100,000 ppm (High range setting) by monitoring the amount of infrared radiation absorbed by carbon dioxide molecules. Carbon dioxide gas moves in and out of the sensor tube by diffusion through the twenty vent holes in the sensor tube. The sensor uses a small incandescent light bulb to generate infrared radiation (IR). The IR source is located at one end of the sensor's shaft. At the other end of the shaft is an infrared sensor that measures how much radiation gets through the sample without being absorbed by the carbon dioxide molecules. The detector measures infrared radiation in the narrow band centered at 4260 nm. The greater the concentration of the absorbing gas in the sampling tube, the less radiation will make it from the source through the sensor tube to the IR detector. The detector produces a voltage that is converted to ppm (parts per million) by the software.

Troubleshooting
- If the reported CO_2 gas concentration appears to be incorrect (after the 90 second warm up), calibrate the sensor as described in the Calibration section. Keep in mind that indoor CO_2 gas concentration can vary a great deal and that there will be unit to unit variability of up to a few hundred parts per million CO_2.
- If the sensor is reading at or near the maximum value for the set range, the CO_2 concentration may be exceeding the maximum value for the setting. Place the sensor back into outside air or ambient room air and wait for the readings to decrease.

- If there is no change in CO_2 gas concentration during an experiment when one is expected, it may be your experiment and not the sensor. Test the sensor by removing it from the reaction chamber and gently blowing on the shaft to see if it responds to your exhalation.

For more troubleshooting and FAQs, see **www.vernier.com/til/1366**

Repair Information

If you have watched the related product video(s), followed the troubleshooting steps, and are still having trouble with your CO_2 Gas Sensor, contact Vernier Technical Support at support@vernier.com or call 888-837-6437. Support specialists will work with you to determine if the unit needs to be sent in for repair. At that time, a Return Merchandise Authorization (RMA) number will be issued and instructions will be communicated on how to return the unit for repair.

Accessories/Replacement Parts

Item	Order Code
BioChamber 250	BC-250
BioChamber 2000	BC-2000
250 mL Nalgene Bottle w/Lid	CO2-BTL

Warranty

Vernier warrants this sensor to be free from defects in materials and workmanship for a period of five years from the date of shipment to the customer (bottle and lid are excluded). This warranty does not cover damage to the product caused by abuse or improper use. This warranty covers educational institutions only.

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