CO_2 Sensor

Description D0357

Figure 1. The CO_2 Sensor

Short description

The CO_2 sensor is used to monitor gaseous carbon dioxide levels in variety of biology and chemistry experiments. It measures in range of 0 to 5000 ppm by recording the amount of infrared radiation absorbed by carbon dioxide molecules. The sensor tube can never be placed into any liquids. The sensor is intended only for measuring gaseous, not aqueous, CO_2 concentration.

The sensor is delivered with 250 ml sampling bottle and split rubber stopper to attach the gas-sampling bottle to the sensor tube.

The sensor uses a hot metal filament as an infrared source (IR), which is located at one end of the sensor tube. At the other end of the sensor tube 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 absorbed in the narrow band centred at 4260 nm. The greater 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 temperature increase in the infrared sensor produces a voltage that is amplified and read by an interface. CO_2 gas moves in and out of the sensor tube by diffusion through the eight vent holes in the sensor tube. When the sensor is collecting data, the IR source blinking on and off – it takes a new reading about once every second.

Calibration

For many measurements it will not be necessary to calibrate the CO_2 gas sensor. The sensor has measurement range between 0 to 5000 ppm[1]. The output voltage is between 0 and 2.5 volt. These values are used as standard sensor settings in Coach 5. Most of the time this calibration is sufficient.
For more accurate measurements, however, the sensor can be calibrated at one known CO_2 level using the calibration button on the sensor box.

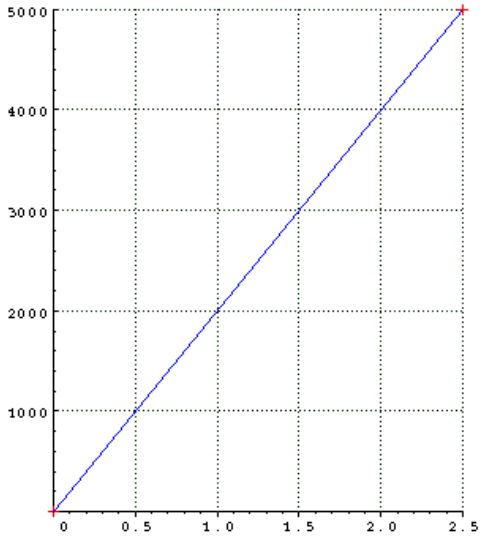

Figure 2. Calibration of the CO_2 sensor.

Sensor calibration

- Place the 250-ml collection bottle (included with the sensor) in the air outside long enough to ensure that its contents are replaced with fresh air. The calibration will be based on this sample having CO_2 concentration of about 400 ppm. While still outdoors insert the rubber stopper into the bottle. Do this by holding the stopper, not the probe box. You can now take the bottle and the sensor to the location where the calibration is to be done.
- Connect the CO_2 sensor to an interface.
- Let the sensor warm up by collection data for at least 90 seconds.
- When the readings are stabilized use a paper clip or the ballpoint to press down the calibration button – release the button immediately after red LED blinks rapidly three times. After about 30 seconds, the reading should stabilize at a value of approximately 400 ppm (plus of min 40 ppm).
- If the reading is significantly lower or higher than 400 ppm, simply press the button again to repeat the process.

[1] The CO_2 sensor measures in units, parts per million, or ppm. In gaseous mixtures, 1 part per million refers to 1 part by volume in 1 million volume units of the whole. This unit can be recalculated to *percent* by dividing a value in ppm by 10000. 5000 ppm is equal to 0.5 %.
The level of $C0_2$ in the earth's troposphere has gradually increased from 317 ppm in 1960 to current levels of nearly 370 ppm. Exhaled human breath has $C0_2$ concentration of about 50 000 ppm.

The name of the CO_2 sensor in the sensor library of Coach 5 program is **CO2 sensor (0357&bt) (CMA).**

Taking measurements with CO_2 sensor

- Connect the sensor to an interface.
- Allow the sensor to warm up for about 90 seconds. While the sensor is warming up, readings increase to circa 5000 ppm and then slowly decrease back to the CO_2 level the sensor is exposed to. Start the measurement.
  Note: Since the sensor updates its reading every second, do not set the data rate (measurement frequency in Coach Program) faster that 1 reading per second.
- Once you have started collecting data, you should see the red LED on the sensor box turn on each time the sensor takes a new reading.

Important

- The CO_2 sensor needs to warm up for 90 seconds anytime power is interrupted. The sensor required a large current (100 mA). Only the UIB, CoachLab II interfaces and the Texas Instruments CBL supply sufficient current.
  For the CBL users is recommended to connect the AC Adapter to the CBL unit when using the CO_2 sensor.
- The sensor can not take readings at a CO_2 concentration higher than 5000 ppm. Once the CO_2 concentration reaches this level the computer will continue to display a reading of 5000 ppm, until the actual level drops below 5000 ppm again.
- Even though the sensor responds rather quickly to change in CO_2 concentration, remember that gas has to diffuse through the holes in the sensor tube before any changes in concentration can be detected. Since diffusion of gases is a fairly slow process, there is resulting delay in the readings. Wafting air toward the sensor tube speed up this process.
- When you finished collecting data, simply remove the sensor from the gas-sampling bottle. We recommend leaving the slit rubber stopper on the sensor tube. Store the sensor in the box it was shipped in.
- The sensor is designed to operate between 20°C and 30°C. The sensor can be used outside of this temperature range; however there will be a loss in accuracy of readings, even if the 1-point calibration at the lower level or higher temperature is done. Allow enough time for the sensor to stabilise at the desired operating temperatures.

Warranty

The CO_2 sensor is warranted for a period of 12 months from the date of purchase provided the electrode has been used in accordance with this instruction manual and under normal laboratory conditions. The warranty does not apply when the CO_2 has been subjected to accident, alternate use, misuse or abuse in any manner.

Suggestions for experiments

- Measuring CO_2 levels (respiration) from small animals and insects.
- Monitoring CO_2 changes in a plant terrarium during photorespiration and photosynthesis in light/dark (combination with the light sensor).
- Measuring CO_2 levels during cellular respiration of peas or beans.
- Monitoring production of CO_2 during chemical reactions
  $Na_2CO_3 + HCL \rightarrow CO_2 + H_2O + NaCl$
- Monitoring CO_2 consumption during chemical reactions:
  $2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$
- Measuring CO_2 levels in classrooms. The air in a classroom during the lesson can reach as high as 1000 to 1200 ppm CO_2.
- Determining the rate at which CO_2 diffuses through a gas diffusion tube.
- Monitoring production of CO_2 during fermentation or respiration of sugars.

Technical specification

CO_2 range	0 – 5000 ppm (0 – 0.5%)
Accuracy (at standard 1 atm):	100 ppm in the range of 0-1000 ppm 10 % of reading in the range of 1000-5000 ppm
Output voltage Output impedance	0 – 2.5 V 1kOhm
Resolution using 12 bit 5V AD converter	2.44 ppm CO_2
Calibration information	Slope: 2000 ppm/V, offset 0V (0V=0 ppm, 2.5V=5000 ppm)
Warm up time	90 seconds (maximum) (faster when air currents are provided)
Response time	95% of full-scale reading in 120 s
Normal operating temperature range	25 °C (±°C)
Operating hum. range	5 - 95 % (non-condensing)
Connection	 BT (British Telecom) plug

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