CO_2 GAS SENSOR BT24i

USER'S GUIDE

CENTRE FOR MICROCOMPUTER APPLICATIONS

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Short description

The CO_2 Gas sensor BT24i is used to monitor gaseous carbon dioxide levels in the range between 0 and 5000 ppm[1]. The sensor uses the Non-Dispersive Infrared Detection (NDIR) method and detects the net increase or decrease of light that occurs at the wavelength where absorption of carbon dioxide takes place. The light intensity is then correlated to CO_2 concentrations.

CO_2 gas moves in and out of the sensor tube by diffusion through the six vent holes in the sensor tube. The tube contains an infrared source at one end of the sensor tube and an infrared detector at the other end. The detector measures infrared radiation absorbed in a narrow band centered at 4.26 µm. The greater the concentration of the absorbing gas in the sampling tube, the less radiation is detected by the IR detector.

When the sensor is collecting data, the IR source blinking on and off – it takes a reading about every 5 seconds.

The sensor is delivered with a 250 ml sampling bottle and rubber stopper to attach the gas-sampling bottle to the sensor tube. Do not place the sensor tube directly into any liquid. The sensor is intended only for measuring gaseous, **not aqueous**, CO_2 concentrations. The CO_2 sensor needs to warm up for 90 seconds anytime when power is interrupted.

The CO_2 Gas sensor can be directly connected to the analog BT inputs of the CMA interfaces. The sensor cable BT - IEEE1394 needed to connect the sensor to an interface is **not supplied** with the sensor and has to be purchased separately (CMA Article BTsc_1).

Sensor recognition

The CO_2 Gas sensor BT24i has a memory chip (EEPROM) with information about the sensor: its name, measured quantity, unit and calibration. Through a simple protocol this information is read by the CMA interfaces and the sensor is automatically recognized when it is connected to these interfaces. If your CO_2 Gas sensor is not automatically detected by an interface you have to manually set up your sensor by selecting it from the Coach Sensor Library.

Calibration

The CMA CO_2 Gas sensor BT24i is supplied calibrated. The output of the CO_2 Gas sensor is linear with respect to the measured CO_2 concentrations. The supplied calibration function is:

$$CO_2 \text{ (ppm)} = 2000 * V_{out} \text{ (V)}.$$

The Coach software allows selecting the calibration supplied by the sensor memory (EEPROM) or the calibration stored in the Coach Sensor Library. For better accuracy the sensor can be calibrated.

For the best accuracy (the sensor's characteristics may change over time) before starting the measurement the sensor should be calibrated at known CO_2 level using the calibration button on the sensor box.

To calibrate the sensor:

- Place the 250-mL sampling bottle delivered with your sensor in the air outside long enough to ensure that its content is replaced with fresh air. The calibration will be based on this sample

[1] The CO_2 sensor measures in parts per million (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 a $C0_2$ concentration of about 50 000 ppm.

having a CO_2 concentration of about 400 ppm. While still outdoors insert the sensor with the rubber stopper into the bottle. You can now take the bottle and the sensor to the location where the measurements will be done.

- Connect the CO_2 sensor to an interface.
- Let the sensor warm up by collecting data for at least 90 seconds.
- When the readings are stabilized use a paper clip or a ballpoint to press down the calibration button. After about 30 seconds, the reading should stabilize at a value of approximately 400 ppm (±40 ppm).
- If the reading is significantly lower or higher than 400 ppm, simply press the button again to repeat the process.

Collecting data

1. Connect the sensor to your interface and let it warm up for at least 90 seconds to assure a stable voltage.
2. You can use the sampling bottle to collect air samples.
3. Calibrate your sensor by using its calibration button. See the calibration procedure above.
4. Start your measurement. The sensor takes a measurement reading about every 5 s (the intensity of IR changes).
5. Even though the sensor responds rather quickly to changes in CO_2 concentration, remember that gas has to diffuse through the holes in the sensor tube before any changes in concentration will be detected. Since diffusion of gases is a fairly slow process, there is a resulting delay in the readings.

Practical information

- The sensor requires a large current (120 mA). We recommend that you use the power adapter for data-loggers. Only one CO_2 sensor can be used at a time.
- The sensor cannot take readings at 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.
- 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 stabilize at the desired operating temperatures.

Suggested 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.
- Measuring CO_2 levels in classroom

Technical Specifications

Sensor kind	Analog, generates an output voltage between 0 - 5 V
Measurement range	0 .. 5000 ppm (0 .. 0.5 %) at 1 atm
Resolution using 12 bit AD converter	2.44 ppm CO_2
Typical resolution	20 ppm
Calibration function	CO_2 (ppm) = 2000 * V_{out} (V)
Live calibration by calibration button	in fresh air ~400 ppm
Accuracy (at standard 1 atm)	100 ppm in the range of 0-1000 ppm 10 % of reading in the range of 1000-5000 ppm
Warm up time	90 seconds (maximum)
Response time	90% of full-scale reading in 60 s
Normal operating temperature range	20 .. 30 °C
Operating humidity range	5 .. 95% RH (non-condensing)
Connection	IEEE1394 connector for BT-IEEE1394 sensor cable. Sensor cable not delivered with the sensor.

Warranty:

The CO_2 Gas sensor BT24i is warranted to be free from defects in materials and workmanship for a period of 24 months from the date of purchase provided that it has been used under normal laboratory conditions. This warranty does not apply if the sensor has been damaged by accident or misuse.

Note: *This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.*

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