CO_2 GAS SENSOR BT25i

USER'S GUIDE

CENTRE FOR MICROCOMPUTER APPLICATIONS

https://cma-science.nl

Short description

The CMA CO_2 Gas sensor BT25i is used to monitor gaseous carbon dioxide levels in the range between 0 and 100,000 ppm[1] (which equals 0 to 10%). The sensor uses the Non-Dispersive Infrared Detection (NDIR) dual wavelength method.

CO_2 gas moves in and out of the sensor tube by diffusion through the vent holes in the sensor tube. The tube contains an infrared source at one end of the sensor tube and a dual wavelength infrared detector at the other end. The detector measures infrared radiation absorbed in a narrow band centered at 4.26 μm (the wavelength where CO_2 gas absorbs most infrared light) and at a second wavelength where no absorption of infrared light by CO_2 gas occurs. This second wavelength is used to compensate for fluctuations in temperature and other external influences. This greatly enhances the stability and accuracy of the sensor. The higher the concentration of CO_2 gas in the sampling tube, the less radiation is detected by the IR detector at 4.26 μm, while the reading at the second wavelength is not affected by the concentration of CO_2 gas.

When the sensor is collecting data, the intensity of the IR source is modulated – the sensor takes a reading about every 3 s.

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 sensor needs to **warm up for 5 minutes** before use.

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 BT25i 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 BT25i 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:

$$CO_2 \text{ (ppm)} = 25,000 * V_{out} \text{ (V)}.$$

The Coach software allows selecting the calibration supplied by the sensor memory (EEPROM) or the calibration stored in the Coach 6 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.

---

[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 10,000. 100,000 ppm is equal to 10 %.

The level of CO_2 in the Earth's troposphere has gradually increased from 317 ppm in 1960 to current levels of about 385 ppm. Exhaled human breath has a CO_2 concentration of about 50,000 ppm.

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 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 5 minutes.
- 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 around 400 ppm. Because of the accuracy of the sensor of 1000 ppm, the actual reading can be anywhere between 0 and 1400 ppm.

Collecting data

1. Connect the sensor to your interface and let it warm up for about 5 minutes 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 3 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 (about 120 mA). We recommend that you use the AC connector for the data-loggers when using the CO_2 sensor. Only one CO_2 sensor can be used at a time.
- The sensor is designed to operate between 20°C and 30°C. The sensor can be used outside this temperature range, however there will be a loss in accuracy. Allow enough time for the sensor to stabilize at the desired operating temperature.
- The sensor is not suitable to measure atmospheric CO_2 levels or small changes, because of its lower resolution and low accuracy for low CO_2 levels. To measure atmospheric or other low CO_2 levels use the CMA CO_2 sensor that measures between 0 and 5,000 ppm.

Suggested experiments

- Measuring CO_2 levels of human breath (about 50,000 ppm).
- Measuring CO_2 levels of various sources.
- Monitoring production of CO_2 during chemical reactions.
- Monitoring production of CO_2 during decomposition of organic materials in soils.

Technical Specifications

Sensor kind	Analog, generates an output voltage between 0 - 5 V
Measurement range	0 .. 100,000 ppm (0 .. 10%) at 1 atm
Calibration function	CO_2 (ppm) = 25,000 * V_{out} (V)
Live calibration by calibration button	in fresh air ~400 ppm
Accuracy (at standard 1 atm)	1,000 ppm in the range of 0..10,000 ppm 10 % of reading in the range of 10,000..100,000 ppm
Warm up time	5 minutes
Response time	< 60s to 90% of final value
Normal operating temperature range	20 .. 30 °C
Operating humidity range	0 .. 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 BT25i 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.

Rev. 05/09/2022