CO_2 GAS SENSOR W02

USER GUIDE

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Short description

The Wireless CO_2 Gas sensor W02 monitors gaseous carbon dioxide levels in the range between 0 and 5000 ppm[1]. The sensor uses the Non-Dispersive Infrared (NDIR) Detection method to measure CO_2 levels. It works by detecting changes in light at a specific wavelength where CO_2 absorbs infrared radiation. The sensor measures the intensity of the light and correlates it to the concentration of CO_2.

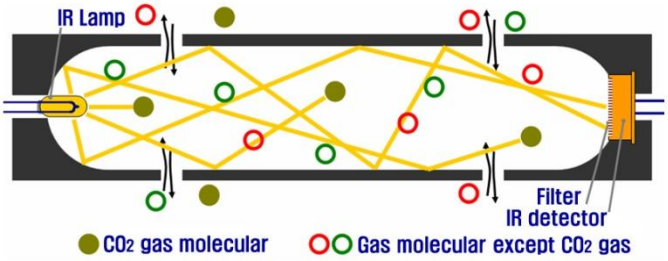
The power button located on the top of the sensor allows you to turn it on and off. The sensor is equipped with an OLED color display which shows sensor information and the measured values. This makes the sensor suitable to use as a standalone measuring instrument.

The sensor can be used wirelessly via Bluetooth or wired via USB with the Coach 7 or Coach 7 lite programs/apps on computers (Windows and Mac), Chromebooks and mobile devices (Android and iOS).

The sensor is designed solely for measuring gaseous CO_2 concentrations, **not aqueous** ones. **Never immerse** the sensor tube directly into any liquid. The CO2 measurement may take some time to stabilize because the gas needs to diffuse through a membrane filter in the sensor probe. Since diffusion is a slow process, it can take a while for the sensor to accurately detect and measure the CO2 levels. The CO_2 gas sensing element is protected from contamination by a membrane filter, so **do not remove** the metal cap of the sensor.

How the sensor works

The Non-Dispersive Infrared (NDIR) Detection method is a technique used to measure gases like carbon dioxide (CO_2) by detecting how they interact with infrared (IR) light.



CO_2 gas diffuses through a membrane filter in the sensor probe, moving in and out of the sensing area. During data collection, the IR source blinks, and the sensor takes a reading every 0.7 s.
The process begins with an infrared light source that emits light through a chamber containing the air sample. As the light passes through, CO_2 absorbs infrared light at a wavelength of around 4.26 µm. On the opposite side of the chamber, a detector measures the amount of infrared light that passes through without being absorbed. The less light that reaches the detector, the higher the concentration of CO_2 in the air. By comparing the amount of light absorbed

[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 CO_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 CO_2 concentration of about 50 000 ppm.

to the expected light transmission, the sensor calculates the concentration of CO_2 in the air.

Calibration

The CO_2 Gas sensor W02 is supplied calibrated with a factory calibration in ppm. The factory calibration may be sufficient in most cases.
You may also choose to calibrate your sensor by setting it to 400 ppm while measuring in fresh air.

- Place a sampling bottle (can be purchased separately at CMA) 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 tube with the rubber stopper into the sampling bottle and close tightly. You can now take the bottle and the sensor to the location where the measurements will be done.
- Turn on the sensor.
- Let the sensor warm up by collecting data for at least 1 minute.
- When the readings have stabilized, double press the power button. The sensor will display a value of about 400 ppm, and the symbol 'UC' will appear to indicate that user calibration has been applied.
- You are ready to use the sensor.

Software

You can use the CO_2 Gas sensor with Coach 7 or Coach 7 Lite (free) program on computers (Windows and Mac) or Coach 7 and Coach 7 Lite (free) app on mobile devices (Android and iOS). For Chromebooks, we offer a special Android app. The support for the wireless CO_2 sensor W02 is added starting from Coach version 7.12. Check the CMA website for the latest installations. https://cma-science.nl/downloads_en

Collecting data without software connection

1. Turn the CO2 Gas sensor on by pressing its power button.
2. The sensor briefly displays its Bluetooth identification code. This ID code is also printed on the sticker located on the bottom side of the sensor box.
3. Then the display shows:
   - the Bluetooth mode, 'Mobile' or 'PC'.
     Mobile indicates Bluetooth Low Energy mode which should be used when working with mobile devices (Android, iOS), Chromebook and Apple computers.
     PC indicates Bluetooth Classic which should be used for Windows computers.
   - the battery level, and
   - the current measured value.
4. Warm the sensor up at least 1 minute.

5. If needed, perform the calibration as described on the previous page.
6. Now you can use the sensor as an independent measuring instrument.
7. While the sensor responds relatively quickly to changes in CO_2 concentration, the gas must first diffuse through the holes in the sensor tube before a change can be detected. Because gas diffusion is a slow process, this results in a delay in the readings.

Collecting data via the Bluetooth connection

Mobile devices, Chromebooks, and Apple computers

For mobile devices (Android, iOS), Chromebooks and Apple computers Bluetooth Low Energy technology is used for wireless communication. For these devices **do not pair** the sensor just use it directly in the Coach software.

1. Turn the sensor on by pressing its power button.
2. Ensure your sensor is set to Mobile mode.
   If the display shows in the top-left corner 'PC' first you must set the sensor to the Mobile mode. Turn off the sensor. Then press and hold the power button until the text 'Bluetooth mode Change Mobile' is shown, then release the button. The mode is set to 'Mobile' which means that Bluetooth Low Energy is used.
3. Start the Coach 7 or Coach 7 Lite program/app.
4. Select the Dashboard Activity 'Measurement with Wireless sensors'.
5. On opening of the Activity Coach starts searching for sensors which are turned on and in the Mobile mode. The found sensors appear in the list.
6. Select the CO_2 sensor you want to connect to. If needed check the sensor's Bluetooth ID which is located on the sensor's bottom label.
7. When the connection is established, the Bluetooth symbol will appear in the top-left corner of the sensor's display, and the sensor's icon will be displayed in Coach, showing the values measured by the sensor.
8. Now you are ready to use the CO_2 sensor for your measurement.

Windows computers

For Windows computers, Bluetooth Classic technology is used for wireless communication. Before you start to use the sensor for measurement in Coach **you have to pair it**.

1. Turn the CO_2 sensor on.
2. Ensure your sensor is set to PC mode.
   If the display shows in the top-left corner 'Mobile' first you must set the sensor to the PC mode. Turn off the sensor. Then press and hold the power button until the text 'Bluetooth mode Change PC' is shown, then release the button. The mode is set to 'PC' which means that Bluetooth Classic is used.
3. Pair your sensor.
   - Go to the Windows Settings **Bluetooth and other devices** and select **Add Bluetooth or other devices**. Select **Bluetooth device**.

- Windows looks for Bluetooth devices and after a while lists discovered devices. The wireless sensors are listed with their Bluetooth IDs.
- Select the sensor you want to connect to. If needed check the sensor's Bluetooth ID which is located on the bottom label of your sensors.
- When the connection is successfully established Windows indicates that the sensor is paired and ready to go.
- Click **Done** to accept it. The sensor appears in the list of paired Bluetooth devices.

4. Start the Coach 7 or Coach 7 Lite program.
5. Select the Dashboard Activity 'Measurement with Wireless sensors'.
6. Coach starts searching and displays the list with detected sensors, even if they are not paired.
7. Select the CO_2 sensor you want to connect to. If needed check the sensor's Bluetooth ID which is located on the sensor's bottom label. If the sensor was not paired yet Coach will force you to pair the sensor first via Windows Settings.
8. When the connection is established, the Bluetooth symbol will appear in the top-left corner of the sensor's display, and the sensor's icon will be displayed in Coach, showing the values measured by the sensor.
9. Now you are ready to use the CO_2 sensor for your measurement.

Collecting data via the USB connection

The CO_2 sensor can also be used as a USB sensor for both Windows and Mac computers.

1. Turn the CO_2 sensor on.
2. Use the provided USB cable to connect the sensor to a USB port.
3. Start the Coach 7 or Coach 7 Lite program.
4. Select the Dashboard Activity 'Measurement with Wireless sensors'.
5. The connected CO_2 sensor should be detected automatically, and its icon appears on the first empty sensor position in the Wireless sensors panel.
6. When the connection is established the USB symbol appears in the top-left corner of the sensor's display and the icon shows measured data.
7. Now you are ready to use the CO_2 sensor for your measurement.

Practical information

- The CO_2 sensor requires a **1-minute warm-up** whenever power is interrupted.
- The sensor **cannot measure CO_2 concentrations above 5,000 ppm**. Do not use it beyond its specified range, as prolonged exposure to excessively high concentrations can cause serious damage.
- The sensor is designed to operate best between **20°C and 30°C**. While it can function outside this range, accuracy will decrease, even if a one-point calibration is performed at a lower or higher temperature. Allow sufficient time for the sensor to stabilize at the desired operating temperature.

- **Never** unscrew the metal cap at the end of the sensor probe, as it protects the sensor element.

Charging a battery

An internal rechargeable battery (Li-Poly 3.7 V, 700 mAh) powers the sensor. The battery symbol located in the top-right corner of the sensor's display shows the battery level. When the battery level becomes critical, the battery gauge shows an empty battery. Use the provided cable to connect the sensor to a USB port for charging. A fully discharged battery requires up to 2 hours of charge time to become fully charged again. To prolong battery life, automatic power down turns the sensor off after a few minutes of inactivity.
To replace the battery, use **only** the approved rechargeable batteries provided by CMA.

Warning: If your sensor shows **0 ppm** and does not respond, it may indicate that the battery is insufficiently charged for proper sensor operation.

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
- Measuring CO_2 levels during yeast respiration
- Monitoring production of CO_2 during chemical reactions
- Measuring CO_2 levels in classroom
- Measuring CO_2 changes from decomposing organic matter

Technical Specifications

Measuring range	0 .. 5000 ppm
Resolution	1 ppm
Maximal sampling rate	1 Hz
Warm up time	1 minute when operating in temperatures between 20 and 30°C
Response time	~ 65 s to reach approximately 63 % of its final value
Conditions	Recommend 20 to 30 ℃, ~ 85% RH
Supply current (typical)	200 mA
Battery life after full charge	Approximately 4 hours Battery life varies by use, configuration, temperature, and many other factors; actual results will vary.
Connection	Bluetooth 5, Low Energy (Mac, Android, iOS) Bluetooth 2.1, Classic (Windows) USB 2.0 (type C)
Bluetooth ID	W02CO2-xxx

Warranty

The CO_2 sensor W02 is warranted to be free from defects in materials and workmanship for a period of 3 years 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.

The sensor battery is consumable and is warranted to be free from defects in materials and workmanship for a period of 12 months from the date of purchase.

Discard batteries according to local regulations.

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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