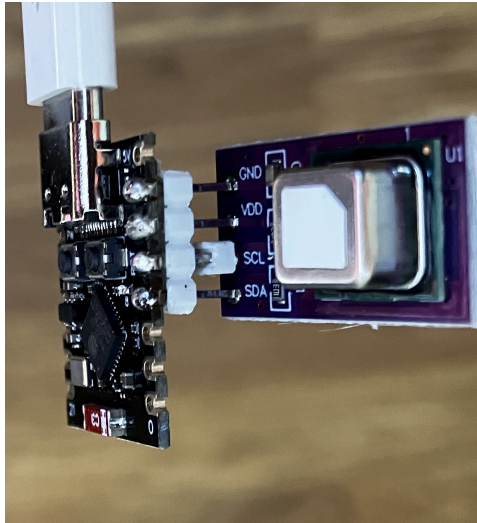


A Cheap but Good DIY CO2 Sensor for Measuring the Adequacy of Ventilation



A sensor that measures CO2 in PPM, Temp and Humidity using Sensirion Bluetooth app, MyAmbiance, with LEDs that blink in accordance with CO2 levels.

Instructions on how to make your own device and the Arduino sketch for the device can be found at this link...

[SCD40 MyAmbiance calibration ESP32C3mini](#)

Solid **red** - CO2>801 ppm

Solid **red** AND blinking **green** or **blue** LED - CO2 between 601 ppm and 800 ppm

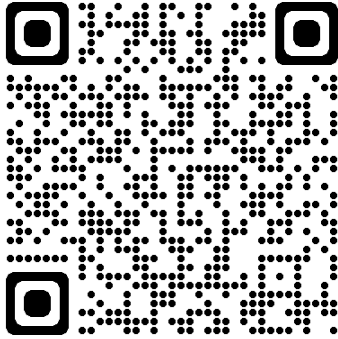
Solid **red** AND solid **green** or **blue** CO2 is less than 600 ppm, this is ideal.

All sensors drift. To see if your sensor needs calibration, take it outside and step away from it for a few minutes. If it reads between 50 ppm from the set point you set for outside air, it is within range. To calibrate the sensor, put it outside for at least 3 minutes. Stand a few feet away and run the calibration protocol from the MyAmbiance app. From the dashboard, click on the Gadget settings button (to the right of the heart). A good approximation of outside CO2 is 420 ppm (and rising).

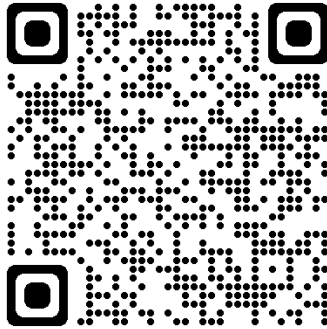
The reason you want to know a room's CO2 is so you can take action to reduce your exposure to respiratory pathogens. CO2 is a proxy for pathogens. CO2 is exhaled by humans at 20,000-40,000 ppm. Outside air is ~420 ppm. If windows can not be opened, HEPA can provide clean makeup air. At CO2 greater than 800 ppm, SARS-CoV-2 remains capable of causing an

infection longer in the air than when the CO₂ is less lower. This is because CO₂ lowers the pH in the respiratory aerosols, which allows the virus to retain infectivity.

MyAmbiance link for IOS



Link for Android



- Bluetooth on your device needs to be enabled and the app needs to have permissions for bluetooth
- On some Android devices location permissions needed. Location information isn't stored, however this is required by the bluetooth functionality since on some Android versions these are coupled
- The gadget needs to be in a range of 10-15 meters from the mobile phone

The sensor has automatic baseline calibration for CO₂. If left plugged in 24/7 in a space that sees fresh air levels of CO₂ a few times a week, it will stay calibrated. If you only use it with the battery in high CO₂ spaces, the lowest reading it sees in a week will be set as 420 ppm. Most commercial buildings will get to 420 ppm when not occupied for 12 hours. Houses that are tightly sealed can have air exchange rates of 0.3/hour, baseline calibration will creep up even if left plugged in 24/7. To reset baseline, leave it plugged in outside, a car or garage will do. Alternatively, you can do math, leave the sensor outside, walk 5 feet away so your breath is not detected then open the MyAmbiance app. The reading should stabilize after a few minutes. Subtract 420 from the reading if it is over 470 ppm to calculate your offset. The sensors are supposed to be within 40 - 50 ppm of actual, but from my experience, they are more like 60 ppm. This is still good enough for determining the adequacy of indoor ventilation. If you want

to upload a sketch for calibration, brief instructions are at the end of this document. Ignore the first 10 seconds of CO2 readings.

Temp will be elevated since it is soldered onto a heat generating ESP32C3. The first humidity (+/- 6%) and temperature (+/- 1 C) immediately after powering the unit on should be accurate. Here is a **calculator** based on ASHRAE 241 to help you figure out how much makeup HEPA you need, based on CO2, the number of people and the activity level. [CADR CALCULATOR](#)



A CO2 over 1000 ppm causes a slight decline in learning, and academic performance. At 1200 ppm most people start showing measurable declines in alertness, memory and the ability to learn. A dull headache is common. At higher levels, reaction time, sleepiness and headaches become more pronounced over time. HEPA filtration will not remove CO2, but it will remove pathogens that are floating in respiratory aerosols. Sources of combustion, like a pilot light, car exhaust or a fireplace will increase CO2.

Less than 600 ppm is low risk air. A HEPA filter should be added if people are singing or exercising to mitigate increased aerosol emissions and to provide for adequate air mixing. A CADR of 40 CFM/person is advisable for these activities with CO₂ less than 600 ppm.

CO₂ between 601 and 800 ppm is better than current building standards, and is considered adequate for reduced far field (out of spitting distance) transmission of respiratory pathogens for quiet people who are sitting. Most hospitals are in this range, although waiting rooms will probably be higher if more than ½ full. This is considered an adequate range for high school classrooms. A CO₂ of less than 800 ppm reduced transmission of Covid by 80% compared to over 1000 ppm in a school study. A CO₂ in this range will not eliminate near field, aka spitting distance, transmission, but it will reduce it. If people are talking or singing, the amount of virus in the air increases by a factor of 2 to 10 depending on how loudly people are vocalizing.

At 800 ppm, 1% of the air you inhale will have been in someone else's lungs. If you are wearing a well fitted N95, and no one else is, your risk is very low. Near field transmission is very possible in this range. HEPA for makeup clean air is strongly recommended in this range.

At 1200 ppm 2% of the air will be rebreathed. Make up HEPA and a well fitted N95 is essential at this range to reduce risk. If you are driving, crack the driver's side window and right side back seat passenger window. Diagonally open windows provide better flow. Make sure the recirc button is off.

CO₂ can rapidly change in a room, and vary depending on the place in a room. If the sensor is within your breathing zone, it can be falsely elevated. If carried in a backpack or purse, the readings are usually good enough. If you breathe on the device, CO₂ will increase within 30 seconds and may take a few minutes to decline to the room's steady state.

The SCD41 accuracy is +/- 40 ppm

The SCD40 accuracy is +/- 50 ppm

