A Guide to Know Milesight CO2 Sensor and Calibration

Created by: Youny Huang
Modified on: Mon, 28 Nov, 2022 at 9:41 AM

Contents

Why Need to Measure CO_2 Level

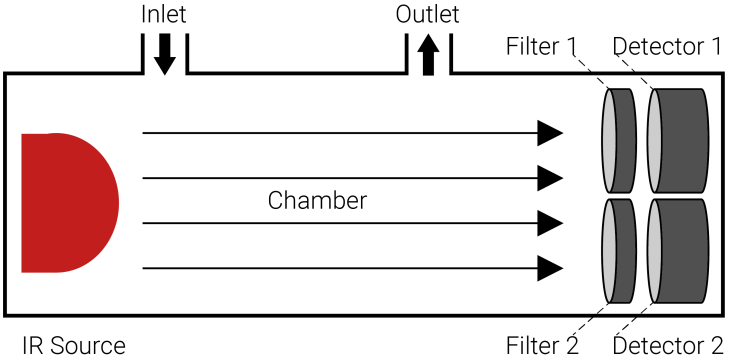
Carbon dioxide (CO_2) is a trace gas of atmosphere at about 400 ppm by volume and is usually generated by respiration of aerobic organisms (human, plants, animals While CO_2 is not regarded as an indoor air pollutant, it is commonly used as a tracer gas for indoor air quality. Too high level of CO_2 concentration will affect the comfort and health of occupants, and therefore many organizations and authorities add CO_2 level as one of the standards to measure indoor air quality. Here are the references of CO_2 level for indoor air quality:

CO_2 Level	Description
400ppm	Normal air level outdoor.
400-1000ppm	Typical level indoors with good ventilation.
1000-2000ppm	Poor air quality - requires ventilation.
≥2000ppm	Headaches, sleepiness and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may also be present.
5000ppm	Workplace exposure limit (as 8-hour TWA) in most jurisdictions.
>40000ppm	Exposure may lead to serious oxygen deprivation resulting in permanent brain damage, coma, even death.

Besides, CO_2 has great effect in agriculture(poultry farming, greenhouse plantings, etc.) , industry (wine-making, mining, etc.) and safety monitoring (forest fire detection).

How does Milesight CO_2 Sensor Work

Milesight provides both indoor air quality monitoring sensors (**AM103/AM103L** (https://www.milesight-iot.com/lorawan/sensor/am103/), **AM107** (https://www.milesight-iot.com/lorawan/sensor/am100/), **AM300 Series** (https://www.milesight-iot.com/lorawan/sensor/am300/)) and **EM500-CO_2** (https://www.milesight-iot.com/lorawan/sensor/em500-co2/) outdoor environment monitoring sensor to cover most daily applications of CO_2 measurement in air. And most CO_2 sensors are based on NDIR(non-dispersiive infrared) principle. A NDIR sensor is usually made up of gas chamber, IR source, optical filter and IR detector. When the air diffuses into the gas chamber, CO_2 gas molecules absorb the 4.26-micron band of infrared of light from IR source and the IR detector will read the remaining amount of light that was not absorbed by CO_2 molecules or the optical filter and calculate the CO_2 level according to Lambert Beer law.
There are two types of NDIR sensor: single channel and dual channel. Milesight uses dual channel NDIR sensor which increase a reference channel and is more accurate than single channel sensor.



Besides NDIR type sensor, AM319 uses a photoacoustic CO_2 sensor to measure the CO_2 level by measuring the sound via a MEMS microphone.

Factors Affecting Accuracy

Even though Milesight CO_2 sensor is calibrated before delivery, the CO_2 accuracy will also be affected by below reasons:

- **Gas sensor difference:** sensor components will be aging over time, and this can be called sensor drift. Besides, even when using the same model sensor by the same manufacturer, there are still a few tolerances even in precisely controlled environments.
- **Installation:** bad installation will affect the air flow to reach air inlet and get accurate value.
- **Environment:** CO_2 level of atmosphere will vary sightly among different locations.
- **Service time:** it is quicker to be inaccurate if the sensor works under the environment with high CO_2 level for a long time.
- **Transportation:** the gas chamber of NDIR sensor will be sightly eye invisible deformed during shipping or affected by barometric pressure or storage temperature or affected by barometric pressure or storage temperature.

Therefore, calibration is required when using sensor at the first time and periodically.

How to Calibrate Milesight CO_2 Sensor

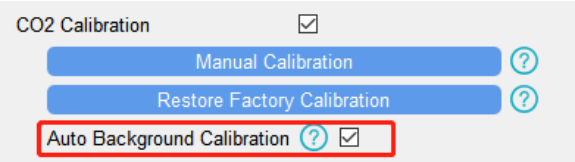
Milesight provides multiple types of calibration and user-friendly ways to ensure the accurate CO_2 measurement. It is suggested to use manual calibration and ABC calibration which are easiest and economical.
Most of Milesight CO_2 sensors can be calibrated by below operations:
1. Download **Milesight ToolBox** App from Google play or App Store to a NFC-enabled smartphone and attach the smartphone to the NFC area of device to write the calibration;
2. Connect type-C port of Milesight sensors to PC, then click **here** (https://www.milesight-iot.com/software-download/) to download **ToolBox software** to calibrate the sensor;
3. Connect the sensor to LoRaWAN network server and send downlink commands to calibrate the sensor remotely.
Note: not all operations are working on every model, please refer to corresponding user guide: **https://www.milesight-iot.com/documents-download/** (https://www.milesight-iot.com/documents-download/)

ABC Calibration

Auto Background Calibration (ABC) allows the sensor to record the offset between 400ppm and lowest CO_2 level during a calibration period of 180 hours (about 7 days) and add this offset to original baseline of sensor to complete the calibration. For example, if the sensor records the lowest value as 398 ppm during the 180 hours, the ABC offset is 400-398=2 ppm; after calibration, if the sensor measures a 500 ppm value, it will add 2 ppm automatically and display as 502 ppm.
This calibration requires this room not to be unoccupied at times or open doors/windows often to ventilate until the CO_2 level decreases at least once to close to 400 ppm during the whole calibration period. By this way the sensor is able to calibrate automatically and periodically. This calibration is suitable for some applications where CO_2 sensors are placed in **well ventilated or semi-ventilated areas**.

Operating Steps:

Method 1: use ToolBox App or ToolBox software to enable **Auto Background Calibration**.



Method 2: send hex format downlink command: **ff3901** (AM300 series) or **ff3901b4009001** (AM10x) if the device is activated on network server.
Note:

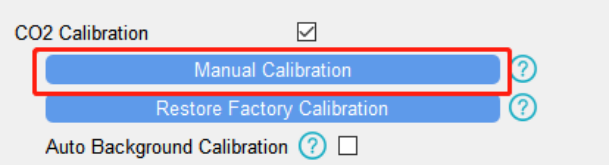
- You need to disable the calibration via ToolBox or send downlink command: ff3900 (AM300 series) or ff3900b4009001(AM10x), or the sensor will start the new calibration period continuously.
- In the new calibration period, the sensor will compare it to the stored baseline in last calibration and if new values show a lower CO2 value while also in a stable environment, the reference is updated with these new values.

Manual Calibration

Manual calibration exposes the sensor to an open outdoor environment for more than 10 minutes to adjust the current value as 400 ppm immediately. This calibration is the fastest but it adapts to the open outdoor environment. This calibration is suitable for some applications which need to place CO_2 sensors in unventilated spaces, you can take sensors out to complete the manual calibration before installation.

Operating Steps:

Method 1: use ToolBox App or ToolBox software to click Manual Calibration after putting sensor to an open outdoor environment for more than 10 minutes.

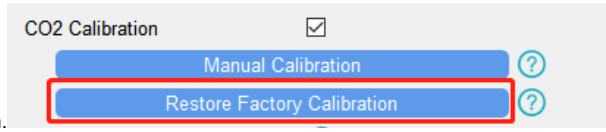


Method 2: send hex format downlink command: **ff1a03** if the device is activated on network server.

Factory Calibration

The sensor will reset the baseline of CO_2 to factory default value immediately. This is the fastest but calibration result may be not ideal.

Operating Steps:



Method 1: use ToolBox App or ToolBox software to click **Restore Factory Calibration**.
Method 2: send hex format downlink command: **ff1a00** if the device is activated on network server.

Zero Calibration

Zero calibration exposes the sensor to a closed space with 100% nitrogen, and then update the zero point of CO_2 into sensor internal memory. While zero calibration can provide the best calibration result, it is a paid service offered by professional organization. It is suitable for the CO_2 measurement in labs or research institutions. Note that AM319 does not support zero calibration.

Operating Steps: send hex format downlink command: **ff1a04** if the device is activated on network server and put to the closed space.

Target Calibration

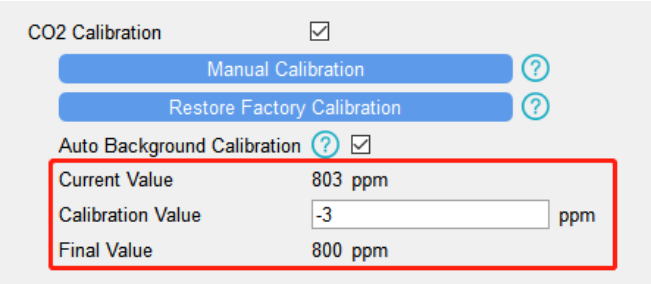
Similar with zero calibration, target calibration exposes the sensor to a closed space with specific concentration of CO_2 to update this CO_2 level into sensor internal memory. It is also a paid service offered by professional organization and is suitable for the CO_2 measurement in labs or research institutions. Note that AM319 does not support target calibration.

Operating Steps: send hex format downlink command: **ff1a02+target value (2 bytes)** if the device is activated on network server and put to the closed space.
Note: AM319 does not support zero calibration.

Numerical Calibration

Numerical calibration allows to add an offset (calibration value), when the sensor collect a CO_2 value, it will add this offset automatically, then display and upload the final value. This calibration can be used if you mind the sightly difference between the two sensors.

Operating Steps: use ToolBox App or ToolBox software to type the calibration value as offset. This offset can be set as positive or negative number.



FAQ

Q1: Can Milesight CO_2 sensor measure the value under 400 ppm?
A: Yes, it will display and upload if it measure the environment CO_2 is really lower than 400 ppm.

Q2: Does the sensor need to be calibrated after rebooting, powering down or pulling out the battery?
A: Not need to calibrate the sensor again, reboot or re-power will not clear your original calibration result, but if you reset the sensor to factory default, please calibrate the sensor again.

Q3: How often should I calibrate the Milesight CO_2 sensor?
A: This depends on the sensor measuring environment. For some ventilated environment, the sensor can be calibrated every 1 year; for some badly ventilated or environments, it is suggested to calibrate the sensor every 3-6 months. Besides, you can select not to disable ABC calibration to calibrate the sensor every 180 hours.

Q4: How to install AM series to ensure accurate CO_2 measurement?
A: The sensor should be installed at the height of human breathing area, it is suggested to install at least 1.5 m from the floor. Besides, do not mount the sensor upside down or block the air inlet.

Q5: What is the sampling interval of CO_2? Can I change the interval?
A: The sampling interval of Milesight CO_2 sensor is 2 minutes (AM319 is 1 minute), and this interval can not be changed.

Q6: Can I set the calibration baseline of CO_2 lower than 400 ppm?

A: Yes, please contact Milesight if you have requirement for it.

Q7: In the Northern Hemisphere, Why the CO_2 level shows lower in summer comparing winter on the sensor ?

A: During the day or in spring and summer, plants take up more carbon dioxide through photosynthesis than they release through respiration, and so concentrations o in the air decrease. Then at night or during autumn and winter, plants reduce or even stop photosynthesising, releasing CO_2 back into the air. Besides, the atmosphere pressure in winter is higher than summer, which will cause more CO_2 than summer.

----END---

Y Youny is the author of this solution article.