

## Calibration of NDIR CO<sub>2</sub> Sensors

SemeaTech Carbon Dioxide (CO<sub>2</sub>) sensors are designed based on Non-Dispersive Infrared (NDIR) technology. An NDIR CO<sub>2</sub> sensor consists of an infrared light source, a CO<sub>2</sub> filter, and a detector. All those components are installed in a sample chamber as shown in Figure 1.

The infrared light source can slowly lose intensity as it ages. Other components of an NDIR CO<sub>2</sub> sensor can be contaminated and aging over time. All these result in so-called sensor drift. Therefore, calibration periodically is required for the concentration of CO<sub>2</sub> to be measured precisely. There are two types of calibration for NDIR CO<sub>2</sub> sensors. One is hardware calibration, and another way is software calibration.

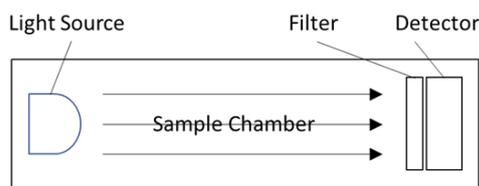


Figure 1

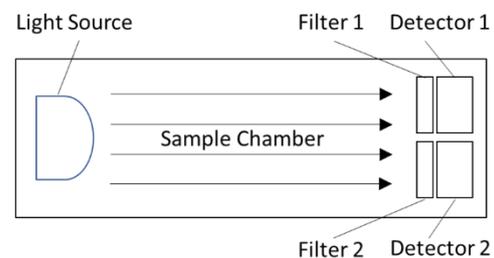


Figure 2

### Hardware Calibration

The hardware calibration is used on dual-channel NDIR CO<sub>2</sub> sensors that have two CO<sub>2</sub> filters and two detectors as shown in Figure 2. One pair of CO<sub>2</sub> filter and detector forms the sensing channel to detecting the CO<sub>2</sub> concentration in the environment, and the other pair is designed as a reference channel in which the filter is slightly changed for a different wavelength that does not detect CO<sub>2</sub> gas in the environment. The reference channel provides the calibration reference to the sensor with the sensor drift data due to the age of the light source, CO<sub>2</sub> filter, detector, sample chamber, etc. Therefore, a dual-channel NDIR CO<sub>2</sub> sensor automatically corrects the measurement from the sensing channel with the drift data from the reference channel to keep the accuracy of the sensor and eliminate the need of manual calibration. The advantage of this design is better accuracy, but the higher cost than a single-channel is a minus.

### Automatic Calibration (Software Calibration)

Due to the rapid development of MCU technology, low-cost single-channel NDIR CO<sub>2</sub> sensors are getting more and more popular. The software calibration is based on the MCU that judges whether the single-channel NDIR CO<sub>2</sub> sensor has been drifting using daily measured data. Under normal circumstances, the concentration of CO<sub>2</sub>

in the indoor air at midnight (there is no one or few people) will drop to 400 ppm that is typical outdoor CO<sub>2</sub> concentration. The sensor picks the lowest point of the daily CO<sub>2</sub> concentration and then performs an automatic calibration. The prerequisite of this calibration method is that the sensor must work continuously. The power outage will restart measuring the CO<sub>2</sub> concentration from the very beginning for the next calibration. So the automatic calibration is not a real calibration. It is an adjustment of achieving possible accurate measurement results. In many applications such as livestock farms, greenhouse, indoor farming, CO<sub>2</sub> concentration could never reach as low as 400 ppm in the automatic calibration period. Therefore, single-channel NDIR CO<sub>2</sub> sensors with software calibration will not provide accurate readings in these applications unless manual calibration is implemented.