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AN131 – CO2 Sensor Calibration: What You Need to Know

All carbon dioxide sensors need calibration. Depending on the application, this can be accomplished by calibrating the sensor to a known gas, or using the automatic baseline calibration (ABC) method. Both have pros and cons you should know.

Why Calibrate?
Most of our products use non-dispersive infrared (NDIR) carbon dioxide sensors. These rely on an infrared light source and detector to measure the number of CO2 molecules in the sample gas between them. Over many years, both the light source and the detector deteriorate, resulting in slightly lower CO2 molecule counts.
To combat sensor drift, during calibration a sensor is exposed to a known gas source, multiple readings are taken, an average is calculated, and the difference between the new reading and the original reading when the sensor was originally calibrated at the factory is stored in EPROM memory. This "offset" value is then automatically added or subtracted to any subsequent readings taken by the sensor during use.

Calibration Using Nitrogen
The most accurate method of CO2 sensor calibration is to expose it to a known gas (typically 100% nitrogen) in order to duplicate the conditions under which the sensor was originally calibrated at the factory. ISO certification is available on our high-end sensors to verify this process for medical or scientific purposes. Nitrogen calibration is also required if CO2 levels between 0-400 ppm will be measured.

The problem with calibrating using nitrogen is the expense. A sealed calibration enclosure, a tank of pure nitrogen, and calibration software is required to match the original factory testing environment. Otherwise, the accuracy of the calibration cannot be ensured.

Calibration Using Fresh Air
Where maximum accuracy is less important than cost, a CO2 sensor can be calibrated in fresh air. Instead of calibrating at 0ppm CO2 (nitrogen), the sensor is calibrated at 400ppm CO2 (outdoor air is actually 390ppm), then 400 ppm is subtracted from the newly calculated offset value.

Fresh air calibration is best for sensors in manufacturing settings or greenhouses where the sensor is constantly exposed to different CO2 levels. It should also be used in products like the TIM10, if the unit is never exposed to fresh air, and our low-cost, hand-held CO2 meters, which can easily be taken outdoors.

ABC Calibration
Manufacturers of early CO2 sensors used in buildings to measure occupancy or indoor air quality (IAQ) levels realized

the difficulty of calibrating wall-mounted units. Removing the units from the wall to bench calibrate was expensive, required trained staff, and with budget cuts calibration schedules were often ignored.

To solve the problem of CO2 sensor calibration for IAQ, SenseAir developed Automatic Baseline Calibration (ABC). The theory behind ABC calibration is that for IAQ use, at some point each day a room is unoccupied, and the CO2 level should return to 400ppm, the same as outdoor air. By storing the lowest CO2 readings taken over time (typically several days) in EPROM memory, an offset to 400ppm could be calculated, then added or subtracted from the actual CO2 readings.

The advantage of ABC is that the CO2 sensor is self-calibrating over the life of the sensor. The disadvantage is that if the sensor never "reads" normal 400ppm air, over time it will display inaccurate CO2 levels.

When To Use ABC Calibration
ABC calibration is best suited for HVAC or any situation where fresh air CO2 levels can be recorded by the sensor every few days. Otherwise, known gas (either nitrogen or fresh air) calibration should be used. Many of our products have the ability to turn ABC on or off in the software, depending on how the sensor will be used.

How Often Should A CO2 Sensor Be Calibrated?
The more accurate CO2 level reading required, the more often it should be calibrated.

- Scientific Experimentation – Before each test
- Personal Safety – Weekly to monthly
- Greenhouse – After each growing season
- Manufacturing – Bi-Annually to Annually
- Indoor Air Quality – Annually, or not required if ABC is used

These are general guidelines. Calibration schedules may also be dictated by experimental protocols or by particular industrial standards. Consult your specific sensor requirements for your application.