AN007: Auto-Zero Setting CO_2 Sensor

ABSTRACT

All Gas Sensing sensors use a technique called non-dispersive infra-red (NDIR) sensing where light is injected into the optical measurement chamber, which contains the gas which has been allowed to enter it. The light that passes through the optical cavity is detected by the photo diode. The signal from the photo-diode is digitised by the microcontroller and compared with a reference level stored in memory. The microcontroller can then calculate the level of CO_2 in the optical measurement chamber.

All Gas Sensing sensors are 100% tested for measurement accuracy at multiple, different gas concentrations before leaving the factory. In use, and dependent on the conditions, the CO_2 concentration value measured by the sensor may vary from the reference value.

Gas Sensing sensors have a typical operational lifetime of more than 10 years. However, during use, the sensor optical path will change very slowly over time due to the degradation of the optical surfaces caused by environmental contamination, and reduced LED output.

This application note describes potential strategies to correct for these changes and ensure the sensor continues to provide highly accurate CO_2 measurement results.

The Gas Sensing sensor has a built-in automatic method to correct for low rate drift of the sensor 'zero-point'. Alternatively, the user can make manual adjustments to the zero value of the sensor.

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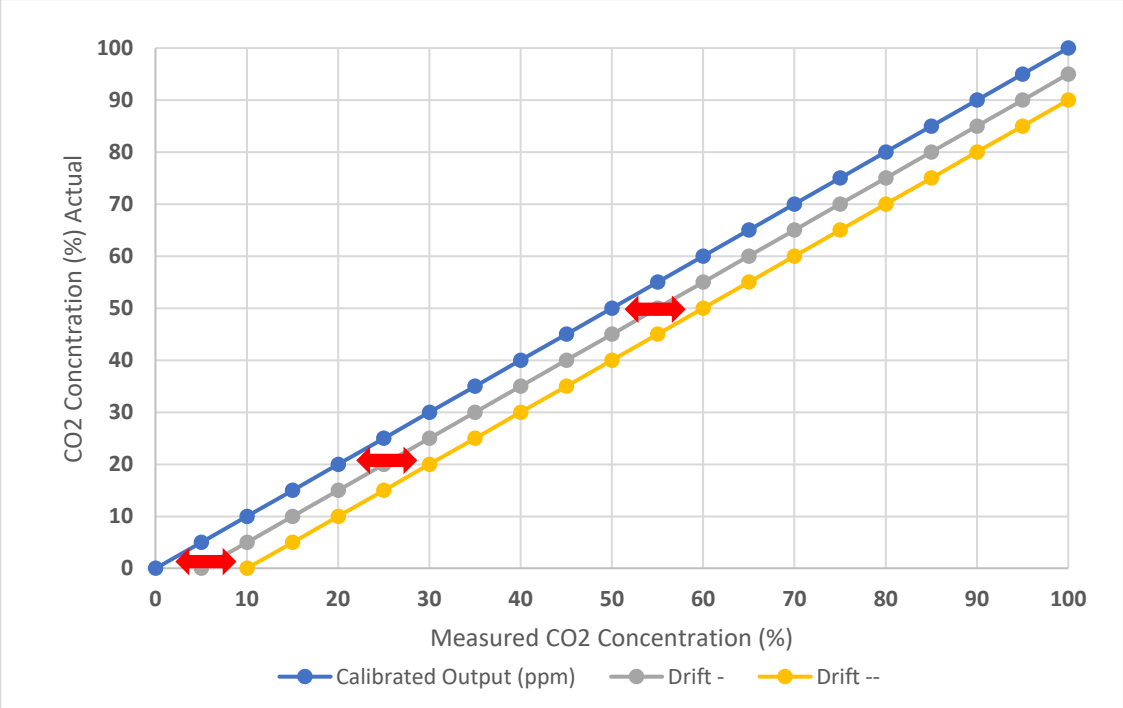
BACKGROUND TO ZERO-POINT SETTING

All Gas Sensing sensors are calibrated for accuracy at the factory at multiple different concentration levels. In use, the sensor reference level will change, due to changes in the optical surfaces, accumulation of dirt in the sensor and other degradations. Although the wavelength of the light being emitted by the LED is not affected, the impact of these changes will be to reduce the signal level received by the photo-diode in the sensor.

The relationship between CO_2 concentration and measured CO_2 remains linear over time. However, the reference levels may change compared to the those stored in the sensor when it was shipped from the factory.

The change in reference level of the sensor can be cancelled out using a process known as zero-setting. This resets the sensor to a defined concentration level. The sensor zero-point can be reset by the user, or in some circumstances, the sensor can operate fully autonomously and periodically 'auto-zero' without user intervention.



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AUTO-ZERO SETTING PRINCIPLE OF OPERATION

All Gas Sensing sensors are calibrated using a variety of different CO_2 gas concentrations during factory calibration, typically calibrated mixtures of nitrogen and CO_2. In practice, it is difficult in use to replicate these known gas calibrations to reset the 'zero-point' of the sensor.

The built-in auto-zero setting process relies on resetting the zero-point of the sensor using the measured 'fresh air' CO_2 concentration value. Therefore, to use the auto-zero setting function, the sensor must be exposed to fresh air for correct operation. The sensor must be put fresh air and time allowed for the sensor temperature to stabilise, and for the fresh air to be fully diffused into the sensor.

All Gas Sensing are pre-programmed by default to continuously take CO_2 measurements when powered-up. Except for the CozIR®-Blink, when powered-up, Gas Sensing sensors will keep a record of the lowest measured CO_2 value in memory. This value will be used by the sensor when the auto-zero setting process is activated. This value is lost when the sensor is powered down.

The CozIR®-Blink, which is designed to be power cycled, keeps a record of the lowest measured CO_2 value in memory even when powered down.

In either case, when the auto-zero function is run, the sensor will reset the fresh-air zero point to the lowest measured CO_2 value that has been stored in memory. The value the sensor uses for this fresh-air zero-point is user programmable. The sensor default value for CO_2 in fresh air is 400ppm. When the auto-zero function is run, the sensor sets the reference value of CO_2 of the fresh air to 400ppm. The default value can be changed by the user if needed.

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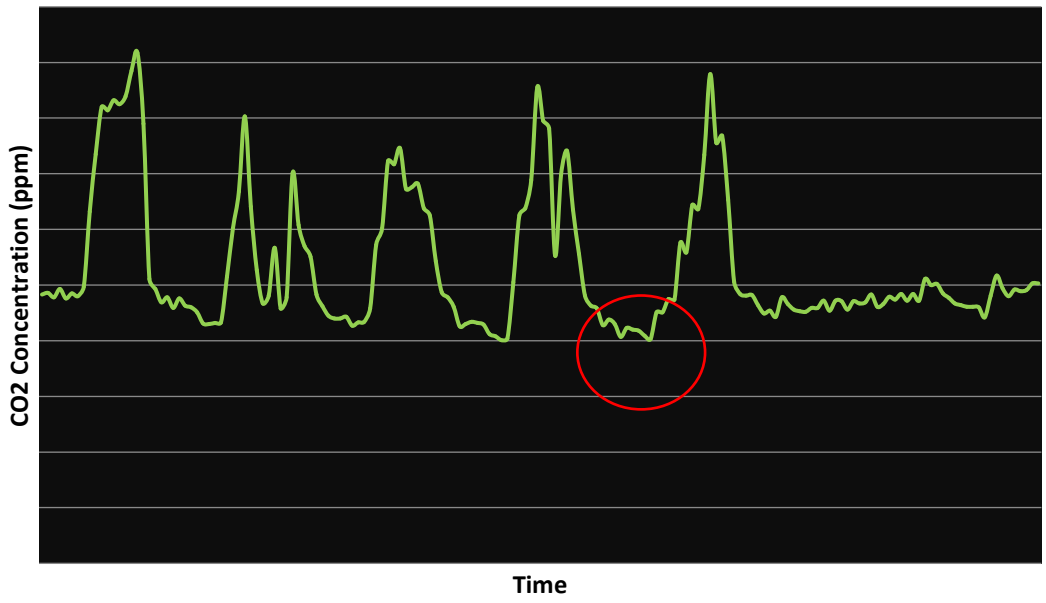
AUTO-ZERO INTERVALS

Depending on sensor type, the intervals between auto-zero events can be programmed either based on time, or on the number of power cycles. The auto-zero time period or the number of power cycles can be programmed by the user.

With the exception of the CozIR-Blink, all Gas Sensing sensors can be programmed to undertake an initial auto-zero after power-on. This means the sensor must be exposed to 'fresh air' at least once during this initial period. Thereafter, the auto-zero period can be set independently of the start-up auto-zero time. Note, the auto-zero settings are reset if the sensor is powered down.

The example below shows a recording of CO_2 measurements over a period of 8 days. The sensor keeps a record of each lowest CO_2 reading. In this case, the stored value will be the one that was measured by the low point circled in red.



For CozIR®-Blink, the user can determine the auto-zero event frequency by setting the number of power cycles. All settings are retained by the sensor, even if it is powered down.

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AUTO-ZERO SETTINGS

By default, the sensor will automatically 'zero' using the measured CO_2 level sampled during the auto-zero period. The auto-zero function can be enabled to operate automatically, disabled, or can be forced. The user can also independently adjust the CO_2 level used for auto-zeroing. All Gas Sensing sensors have a zero-setting function that allows the user to set the measurement value of 'fresh air'. This is called the ZERO IN FRESH AIR reset value. Typically, the auto-zero reset value is set to the same value as the ZERO IN FRESH AIR reset value, but it can also be set at a different level if desired.

SUMMARY

All Gas Sensing sensors have the capability to auto-zero without any user intervention or off-sensor processing or control logic. To operate correctly, the sensor must be exposed to 'fresh air' at least once during the auto-zero period.

The best configuration will depend on the application. In some applications, it may be best to run the auto-zero function at every power-up. For others, particularly ambient CO_2 level measurement, best practice would indicate running the auto-zero function over a much longer period, typically a week.

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