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The technical content of this Cambridge CMOS Sensors (CCS) document is still valid.

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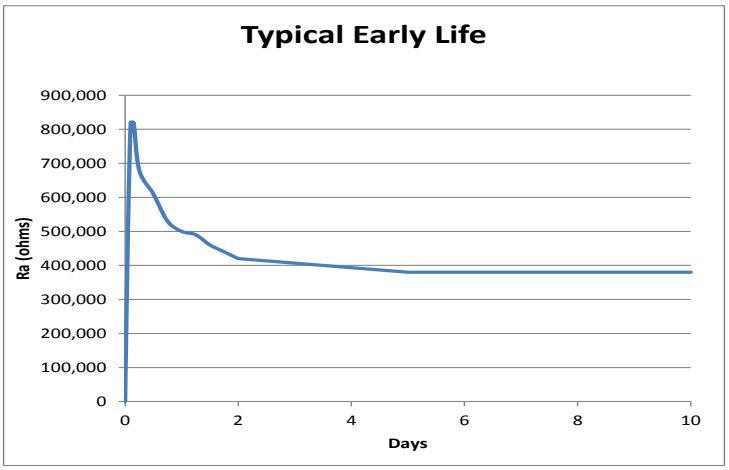
IAQ User experience during initial operation

This whitepaper documents some key considerations when using CCS8xx product family of MOX gas sensors for the first time and the potential impact on the Indoor Air Quality (IAQ) end-user experience in the first few days of operation.

CCS8xx refers to CCS811 and CCS801 with MOX software libraries which include proprietary algorithms.

Early-Life Use

CCS8xx performance in terms of resistance levels and sensitivities will change during early life use. The following chart shows typical early resistance over multiple devices.



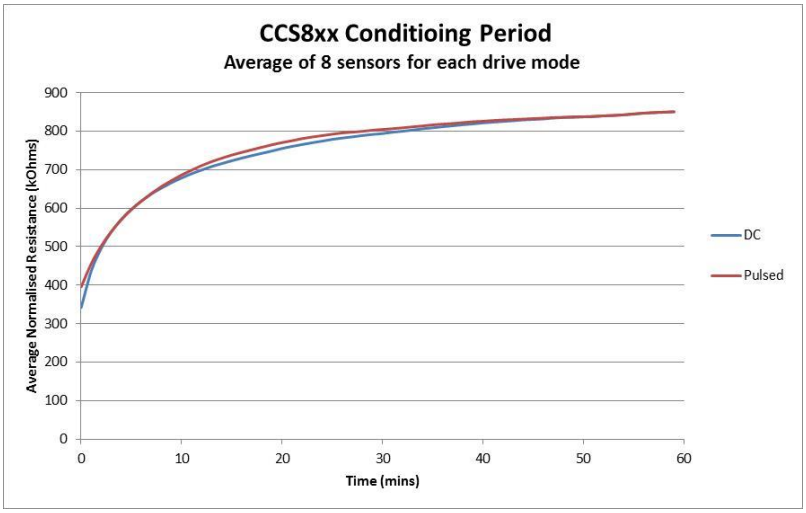
Typical Early Life change in baseline resistance (Ra)

During the early life phase the change in resistance is greatest over the first 24 – 48hrs of operation. Burn-in is a process to accelerate this phase of the CCS8xx, and thereby minimise changes during normal user operation.

Cambridge CMOS sensors (CCS) recommends where possible CCS8xx runs in continuously for at least 24hrs to ensure performance is more stable and can be used to provide a more accurate indication of the IAQ level.

Conditioning Period

The conditioning period is the time required to achieve good sensor stability before measuring VOCs after power-on. The chart below shows the average of 8 x CCS8xx sensors in DC (1s mode) and Pulsed (60s mode). If the CCS8xx sensor has been left in an idle condition for 8 hours or more, then CCS recommends running the CCS8xx initially for >20 minutes before measuring the IAQ level. This applies to all IAQ modes supported by CCS8xx.



CCS8xx Sensor Conditioning Period

CCS8xx could be used with much shorter conditioning period, but this will result in inaccurate IAQ readings until the sensor is warmed up.

Environmental Changes

TVOC and eCO_2 readings generated by CCS8xx while monitoring VOCs will be impacted by humidity and temperature changes. CCS recommends that an external temperature + humidity sensor is included in the system design.

This information can be written to CCS8xx by the host system and used to compensate for temperature and humidity changes.

24hr Automatic Baseline Correction

The CCS8xx continuously monitors the baseline that is used to calculate the TVOC and eCO_2 concentrations in all modes of operation. The VOC concentration levels will vary in typical indoor environments so the recommended minimum time over which an automatic baseline correction is implemented is 24 hours. CCS8xx automatically tracks the lowest level over a 24hr period.

Corrections are expected to be small but may occasionally be observed.

IAQ monitoring in a Polluted Environment

CCS8xx only detects relative changes to gas concentrations. This means the sensor will initially calculate the gas concentration for the ambient air treating this as clean air. This will automatically change when the sensor is exposed to clean air. Then if the air quality deteriorates this will produce a more accurate IAQ reading.

To avoid accuracy issues during start-up when operating in a polluted environment for a long period, CCS8xx supports saving and restoring of the baseline. A clean air baseline for this particular sensor needs to be saved by the application when clean air has been encountered after the conditioning period and not during early life. The CCS8xx has no way of retaining the baseline value in non-volatile memory (NVM) so this needs to be saved by the host system and restored to the CCS8xx register periodically.

The clean air baseline is considered to be unique for each sensor and is not constant, therefore will change over the time as the sensor ages. CCS recommends that the baseline is saved periodically by the application every 24 hours. This allows the most accurate baseline to be written to the CCS8xx the next time the sensor is powered on.

End-User experience

CCS8xx will detect low level of VOCs typically found in indoor environments and CCS software libraries with proprietary algorithms and example applications are available to represent the measured values as an equivalent CO_2 level.

The following table illustrates the effects of poor indoor air quality, and default levels set for good, moderate and poor indoor air quality indicators in CCS8xx.

Air Quality Indication	VOC Level	CO_2 Level	Effects of poor Indoor Air Quality
POOR	High	> 2500 ppm	Long Term Exposure: Carcinogenic, Lungs, Liver, Kidney & Central Nervous System damage Eye, Nose, Throat, Skin Irritation, Headaches, Nausea, Dizziness Significant Impairment of Performance & Decision-Making.
MODERATE	Medium	1500 – 2500 ppm	Eye, Nose, Throat, Skin Irritation, Headaches, Nausea, Dizziness Moderate Decision-Making Fatigue, Impairment and Concentration.
GOOD	Low	< 1500 ppm	No impact on health or decision making

Effects of poor Indoor Air Quality

These levels indicate issues with poor indoor air quality in your local environment and alert the end-user to take appropriate action. During early life use CCS8xx performance in terms of resistance levels and sensitivities will change therefore the initial IAQ indication may not be accurate. CCS recommends in the first 24hrs of operation the end-user treats any IAQ indication with caution or ignores them.

Summary

To avoid IAQ inaccurate readings in first few days of operation CCS recommends the following:

- Due to early life behaviour the sensor should be powered-on and run in continuous operation for at least 24hrs to avoid inaccurate IAQ readings
- A conditioning (warm-up) period of >20mins if sensor have been idle for more than 8hrs
- An external temperature + humidity sensor is fitted to provide feedback to CCS8xx to compensate for environmental changes
- A new baseline value is saved periodically by the application every 24 hours
- In the first 24hrs of operation the end-user should treat any IAQ indication with caution or ignore them.