Application Note

AN000370

CCS811

Baseline Save and Restore on CCS811

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Content Guide

1 Introduction

This application note describes the baseline “save and restore” implementation supported in the CCS811 application firmware. The baseline “save and restore” feature enables the sensors to indicate the air quality of the ambient conditions as soon as possible from powering on the sensor regardless of those conditions. The feature needs to be implemented using a particular sequence and timing to be effective.

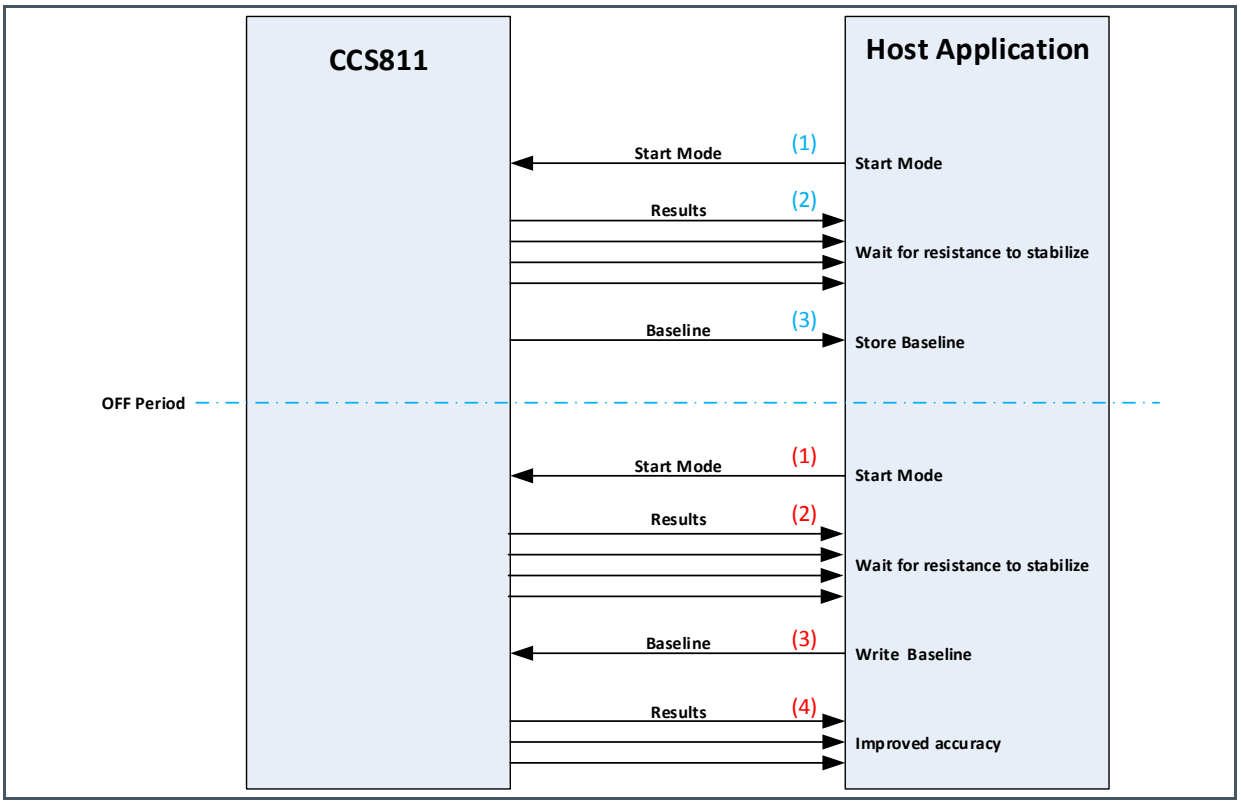
2 CCS811 Baseline Save and Restore

The register address for the save and restore functionality is address 0x11, BASELINE. The host should read 2 bytes from this register to obtain the current baseline, or write 2 bytes to this address to restore a previously saved baseline.

The baseline value is not simply the raw resistance value of the sensor in clean air, it also includes some additional factors used by the internal algorithms. It is **not** in a human readable format and should never be modified. The byte order and content must be preserved.

The save and restore flow diagram is shown below in Figure 1.

Figure 1:
Baseline Save and Restore I2C Transaction Flow



The baseline is read from the CCS811's BASELINE mailbox and saved in memory, typically non-volatile, on the host's system. A saved baseline can then be written back to the CCS811 to allow the sensor to indicate the quality of air as soon as possible the next time the sensor is powered on.

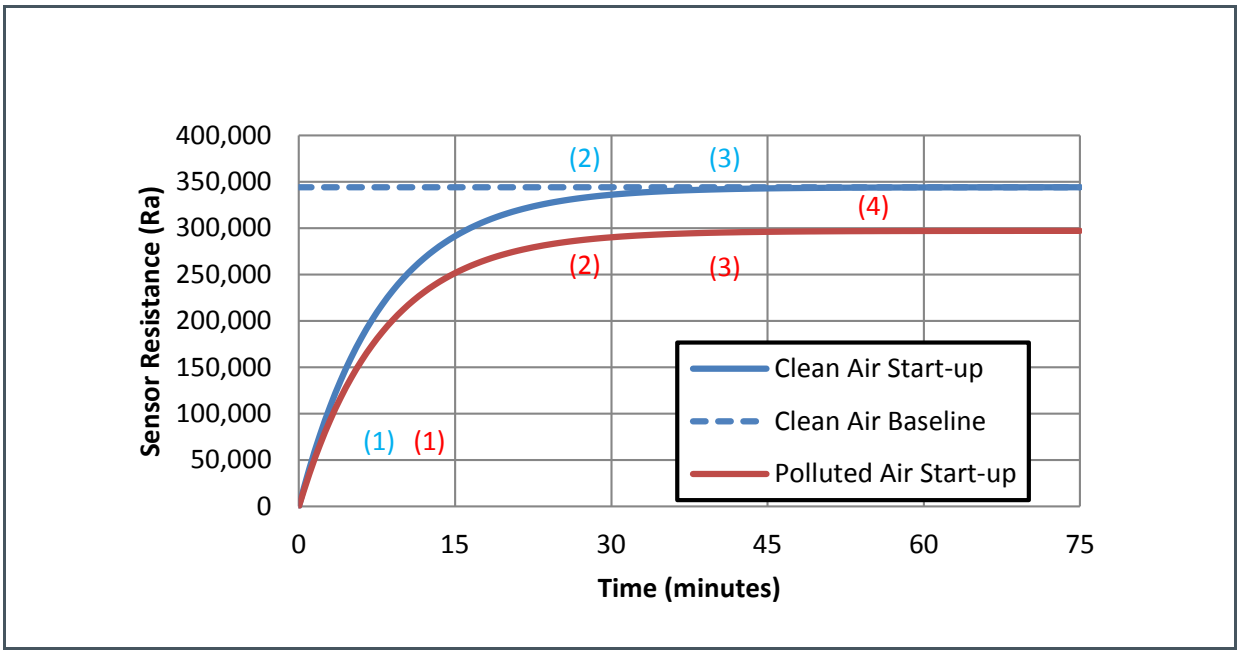
The baseline is relative to the ambient conditions experienced by the sensor from when it is enabled. No data from a previous run time is preserved in the CCS811, so the baseline must be saved before powering off the sensor. For the baseline to be representative of good air quality conditions the CCS811 needs to be exposed to clean air.

3 Polluted Air Start Up

The CCS811 calculates the eCO2 and eTVOC using the baseline as its reference point. It compares the sensors current resistance with the baseline and if the current resistance is less than the baseline then the sensor will indicate the presence of gas. If the current resistance is greater than or equal to the baseline, then the current resistance becomes the new baseline. This is a simplified description, the algorithm is more complex and takes into account ambient temperature and humidity conditions when managing its baseline.

Figure 2 below details the main reason why restoring a previously saved baseline is important for applications that need to indicate air quality as soon as the sensor has warmed up.

Figure 2:
Baseline Save and Restore Timing



The blue line shows that the sensor has stabilized at 350kΩ in clean air. The baseline in this environment and at this point in the sensor's lifetime is therefore 350kΩ (blue dotted line). Saving the baseline at any time after point 3 will yield a value corresponding to 350kΩ. Let's assume the sensor is switched off and then 1 day later is powered on again in dirtier air. This time the sensor stabilizes at 300kΩ as the air is now more polluted, this is shown in the red line.

If no baseline is restored, the CCS811 will assume that a value of 300kΩ represents clean air and will use this as its baseline. It does not retain baseline information from the last time it was powered on. It uses the highest resistance value encountered over a window of time (default 24 hours) as its baseline.

The resistances and sensor output at each point is described below:

1. The sensor is switched on and the baseline is quite close for the polluted air and clean air. In this early phase the sensor will give similar outputs in each start up condition. The baseline must not be written in this period as the baseline resistance will much greater than the sensor's current resistance. This would cause the sensor to falsely indicate very high VOCs concentrations as it's not yet fully warmed up.
2. The conditioning period completes, the resistance in each case shows a visible difference. If no baseline is restored at this point the sensor will give similar outputs in both cases. If the baseline, saved from the clean air start up, is restored then the sensor will indicate that VOCs are present. There will be a larger output on eCO2/eTVOC after the baseline corresponding to 350kΩ is restored. The sensor will now calculate a eTVOC concentration that is relative to the baseline (350kΩ) and the sensor's current resistance (approx. 300kΩ)
3. If no baseline has been restored both environments will yield very similar outputs on the sensor. If the clean air baseline of 350kΩ is restored then this becomes immediately the baseline used by the sensor and the sensor will detect the presence of VOCs in the polluted environment.
4. Same as 3 above. The clean air baseline is the red line, if its corresponding value has not been written at points 2 or 3 the sensor will think the air is clean and its baseline will be 300kΩ. If the baseline is written to the value corresponding to 350kΩ, it will now calculate a eTVOC concentration that is relative to the baseline (350kΩ) and the sensor's current resistance (approx. 300kΩ).

4 When to Read the Baseline

- The CCS811 constantly monitors and maintains its baseline. Reading the baseline at any time will return the value that the sensor's algorithms currently calculate to be the cleanest air encountered in a programmable window (default 24 hours). This value can be saved in non-volatile memory on the host system ready to written at next power on.
- The baseline is safe to be read at any time after the conditioning period is complete, however it is recommended to read and save the baseline if the user knows the sensor has encountered clean air at any point after the conditioning period. If this is not known it is best practice to read the baseline directly before powering down the system.
- If an ad hoc power cut is possible it is also recommended to read and save the baseline periodically
- Due to the slow drift that MOX sensors inherently exhibit, the saved baseline will not match the current baseline if it has not been saved for many days.
    - In the first week of operation sensor it is recommended to save a new baseline every 24 hours
    - After 1 week of operation it can be saved every 1-28 days
- If multiple IAQ operating modes are used on the same sensor, the baseline should be stored for each mode. The baseline is mode specific, it is therefore not possible to use the same baseline value for all modes.
- If multiple sensors are operating in the same environment and in the same mode each sensor will maintain its own unique baseline. It is therefore not possible to use the same baseline for all of the sensors operating in the same mode.
- If the sensor is only run for short intervals (under 24 hours) the automatic baseline correction period can be programmed to closely match the duration of the on time.

5 When to Restore the Baseline

- The baseline should be restored after the conditioning period.
- The baseline takes into account the temperature and humidity data that is written to the sensor. If a sensor that has completed the conditioning period is exposed to an environment that is much different in temperature and humidity than its current environment then baseline restoring is recommended. In this case, restoring the most recently saved baseline after the sensor stabilizes (~30 seconds) in the new environment will yield an accurate measurement in the new conditions.

6 Summary of Issues to Avoid

- Do not use one baseline setting for all sensors. The baseline needs to be stored on a device by device basis.
- Do not use the first baseline you have read for the lifetime of the sensor. The baseline will change during the lifetime of the sensor. Periodically re-read and save the sensor baseline e.g. every 7 days
- Do not save or restore the baseline while the sensor is still in the process of warming up. The best user experience would be to allow the sensor to complete the conditioning period before the baseline is written to avoid falsely high eTVOC level indications in the first 20 minutes of operation
- Do not use the same baseline value for all operating modes field settings. Each mode has its own baseline value which must be saved while operating in that mode.

7 Revision Information

Changes from previous version to current revision v2-00	Page
Fixed Typos	All

- Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
- Correction of typographical errors is not explicitly mentioned.

8 Legal Information

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