Field Calibration Guide

For Sensirion's STC Thermal Conductivity Sensor

Sensirion's STC sensors are highly accurate and long-term stable thermal conductivity sensors. They are fully digital and calibrated. To ensure sensor accuracy it is recommended to use field calibration. The STC3x features two calibration methods to ensure full accuracy. This documents explains how to use these two methods: automatic self-calibration (ASC) and forced re-calibration (FRC).

Introduction

The algorithms ASC and FRC adapt the output of the STC3x, which allows to restore the sensor's accuracy over the entire calibration range. Only one reference value is required to achieve the desired result.

The concept behind the ASC and FRC is similar. The main difference is that the FRC uses an instant value provided by the host for field calibration, whereas the ASC assumes a continuous background concentration for field calibration.

For calibration in a production line, we recommend to apply FRC. In applications where the end device is placed in environments with a known background concentration, we recommend to use ASC to ensure accurate readings over time. If conditions at the end user do not fulfill the requirements necessary for ASC, FRC provides means to mitigate deviations.

Forced recalibration

In forced re-calibration (FRC), the user has to feed a reference value from the host side to STC3x. The value provided by the host is used for updating the output and restore full accuracy. The reference value is lost after the sensor is powered down are put to sleep mode. See the datasheet for using FRC in combination with sleep mode.

The effect of FRC takes place immediately. FRC can be executed at arbitrary intervals. Variations of a few 100 ppm in CO2 concentration are of no concern when performing FRC, since these are much lower than the sensor's accuracy. Activating FRC is described in the data sheet.

For the best possible performance, the FRC has to be executed at the temperature that is relevant for the application. For instance, if the application is at 1°C, it is best to perform the field calibration at that temperature.

Automatic self-calibration

The STC comes with the option of on-chip automatic self-calibration (ASC). The datasheet contains details on how to activate the ASC. This feature is designed for applications where there is zero concentration of target gas for the majority of the time. For example, gas detection to monitor dangerous concentrations of CO_2 due to gas leakage from a storage tank. Here, the sensor will see virtually no CO_2 for the vast majority of the time, except in the unfortunate event where a leak does occur.

When ASC is switched on, the STC will run a zero-point self-calibration that gradually adjusts its output over time. The algorithm is optimized for a measurement interval of 1 s.

Custom automatic self-calibration

The on-chip ASC runs with fixed parameters. If it is required to adjust the parameters, the ASC can be implemented on the micro-processor where it can be optimized to fit the application.

The ASC algorithm is based on the condition that the concentration of the target gas is fixed and known for the majority of the time. For example, the leakage example mentioned in the previous section where there normally is 0.04 vol% CO_2. It only produces useful results when this condition is met.

The ASC algorithm adjusts the output of the STC by an offset. The ASC continuously defines and updates an offset Δ by a very small amount for every measurement. The offset is increased when the measured value is above background level of 0.04

vol% and reduced when the measured value is below[1].

For example, consider setting the amount of offset adjustment to 5 ppb ($5*10^{-7}$ vol%) per measurement. When the measured value higher than 0.04 vol%, Δ is increased by 5 ppb. Likewise, Δ is reduced by 5 ppb when it is lower.

The rate at which the automatic self-calibration can adjust the sensor's output depends on the measurement interval. Assuming a measurement interval of 1 s, the above parameters will lead to a reduction of 0.1 vol% in roughly 2 days when only positive values are measured. Of course, once the output is approaching 0 vol%, an increased amount of negative values is measured, thereby slowing down the reduction of the sensor's output until it is stable at 0 vol%. Figure 1 shows a schematic representation of ASC.

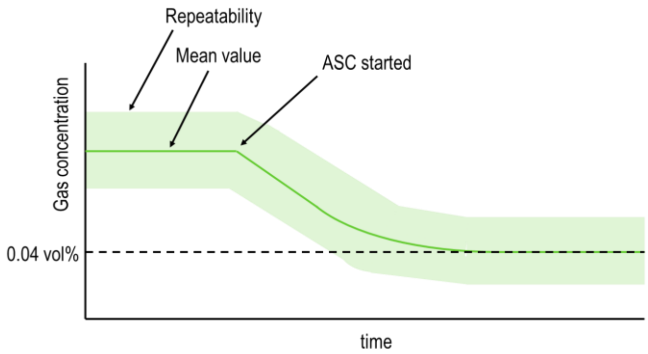

Figure 1 *Schematic representation of custom automatic self-calibration starting from Δ=0.*

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[1] Negative concentrations can be expected by the STC when the target gas concentration is close to zero. Although negative concentrations cannot physically occur, showing them can help to identify potential issues with T, RH or p compensation. In addition, noise can lead to small negative values when the target gas concentration is 0 vol%.