Low Power Mode for SCD30

CO_2, humidity, and temperature sensor

Preface

The SCD30 sensor module is an optical NDIR sensor that measures the CO_2 concentration at regular time intervals. By default, the interval between two measurements is 2 seconds. The SCD30 features the possibility to customize the sampling interval, which can reduce power consumption by more than a factor of three. To ensure accuracy of the CO_2, temperature and relative humidity output signals, subsequent sensor recalibration is necessary. This document provides detailed instructions on how to adjust the CO_2-sampling interval and how to subsequently recalibrate the sensor output signals. Furthermore, the impact of the sampling interval on the response time, power consumption, and the signal accuracy are discussed.

Overview

The SCD30 sensor module features a low power mode that reduces power consumption by more than a factor of three compared to normal mode of operation. This document provides instructions on how to initiate the low power mode, and includes an overview of relevant technical aspects of the SCD30. Figure 1 depicts an overview over the process steps required to operate the SCD30 sensor module in low power mode.

First, a suitable sampling interval for the CO_2 measurements must be determined (i.e. the time between two CO_2 concentration measurements). Second, the sampling interval of the sensor must be set via the digital interface. Third, a recalibration of the CO_2 output signal is necessary. Finally, the temperature offset must be measured and compensated via the digital interface. The first four chapters are dedicated to instructions on how to implement the required process steps. Afterwards, an example of how to initiate the low power mode is provided. Finally, some background knowledge on the SCD30 power consumption and response time is provided.

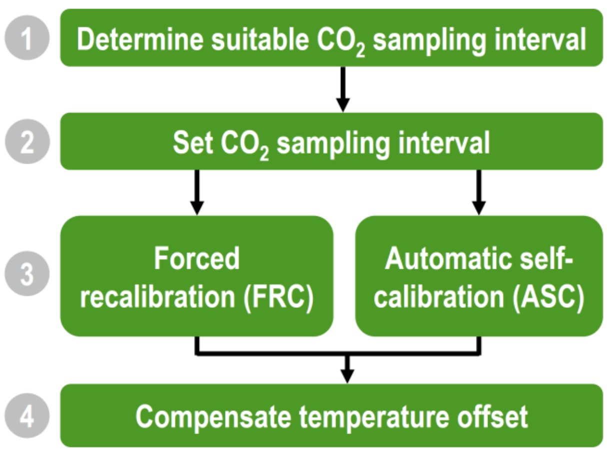

Figure 1: Schematic overview over the process steps that are required to put the SCD30 sensor module into the low power mode.

Finding a suitable sampling interval

As a first process step, the user must decide on a suitable sampling interval. The sampling interval can be set to any integer value between 1 second and 1800 seconds. However, there is an inherent trade-off between low power consumption and fast response time. This is schematically depicted in figure 2: while the power consumption is minimized at high sampling intervals (red curve), the response time is minimized at low sampling intervals (blue curve). Sensirion recommends to apply a sampling interval of 5 seconds - 60 seconds to reduce power consumption while keeping the response time low (green region in figure 2). E.g., when operated at a sampling interval of 15 seconds, the SCD30 average current consumption is 6.5 mA at a response time of 72 seconds.

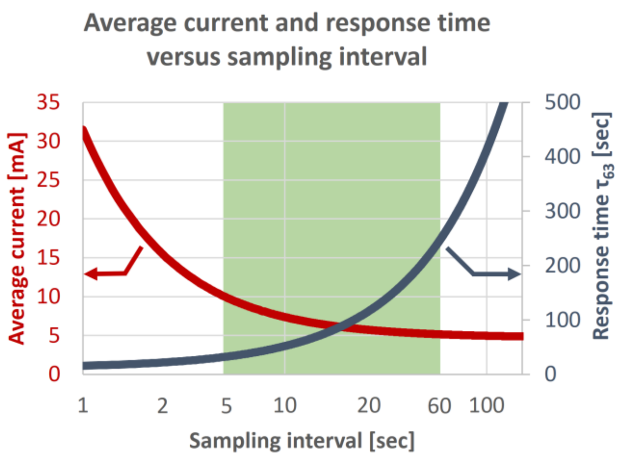

Figure 2: Average current consumption of the SCD30 sensor module as a function of the sampling interval (red, left y-axis). The blue line (right y-axis) represents the response time (τ_{63}) versus the sampling intervals. Both curves are extrapolated from empirical data points. The green region represents the sampling interval range that Sensirion recommends for SCD30 low power operation.

Set sampling interval

The sampling interval is set via the digital interface (I²C or Modbus protocol) (do NOT cycle power to the sensor). The SCD30 interface description provides detailed instructions on how to communicate with the sensor module[1]. Furthermore, an example on how to set the sampling interval to 30 seconds is provided in the chapter *"Example: Set SCD30 to low power mode"*.

Recalibration CO_2 output signal

Modifying the SCD30 sampling interval reduces the accuracy of the CO_2 signal that can result in out-of-spec outputs (fig. 3a). Therefore, a subsequent CO_2 signal recalibration is necessary. After recalibration, the CO_2 output is within the specified accuracy limits for all sampling intervals (fig. 3b).

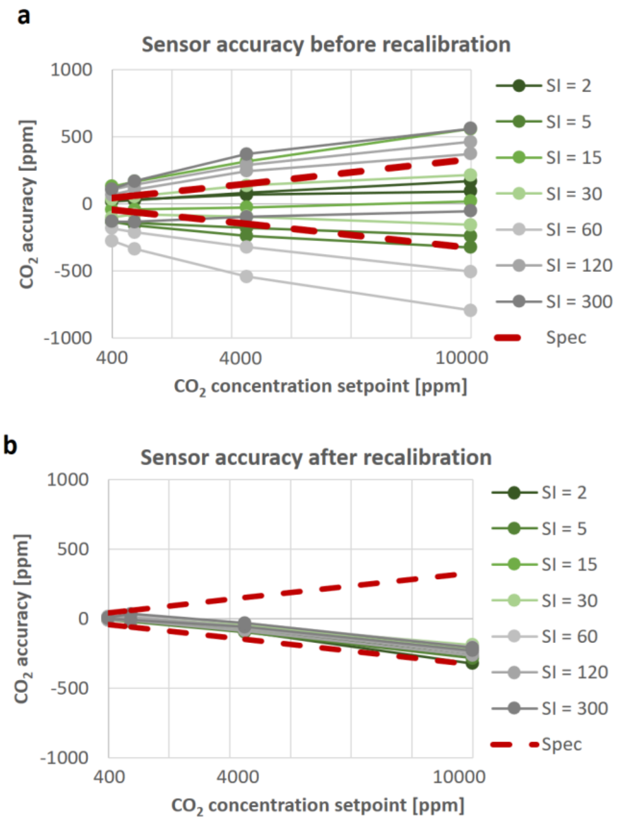

Figure 3: **a)** CO_2 output signal of SCD30 sensors versus CO_2 concentration set points before recalibration. Approximately half of the signal outputs are outside of the specified accuracy limits. **b)** CO_2 output signal of SCD30 sensors versus CO_2 concentration set points after recalibration. The devices exhibit very low device-to-device variation. Both plots display data from 14 SCD30 sensors with various sampling intervals (SI).

[1] www.sensirion.com/file/scd30_interface_description

There are two different ways to perform a SCD30 CO_2 signal recalibration: Automatic Self-Calibration (ASC) and Forced Recalibration (FRC). Advantages, disadvantages, and instructions are discussed in a separate document[2]. Before performing a forced recalibration, the SCD30 should be operated at the newly set sampling rate for at least 6 minutes or 5 times the sampling interval (for sampling intervals larger than 72 seconds) The implementation of the recalibration is done via the digital interface and is described in the SCD30 interface description[1]. Furthermore, an example of a Forced Recalibration is described in the chapter *"Example: Set SCD30 to low power mode"*. It is noteworthy, that the SCD30 will recalibrate by itself after approximately 1 – 3 weeks, if the ASC is activated and the environment fulfills the requirements for successful ASC operation.

Set temperature offset

Self-heating of the SCD30 sensor module results in a temperature offset that shifts the temperature and the relative humidity output signals. The temperature offset mainly depends on two factors: the SCD30 encapsulation/environment and the power consumption of the sensor module. Therefore, the temperature offset is affected by changes of the sampling interval.

The SCD30 temperature offset is defined as the difference between the output temperature and the actual ambient temperature. The actual ambient temperature should be measured with a separate calibrated reference temperature sensor that is not in contact with any heat source. The SCD30 must be operated in the desired application at the correct sampling interval to determine the offset temperature. Furthermore, the application device should be operated continuously to account for external heating of the SCD30. After the new sampling interval has been set, the user should wait approximately 10 minutes to allow thermal stabilization. Subsequently, the SCD30 offset temperature is obtained by subtracting the reference temperature from the SCD30 output temperature. If the temperature offset has been set previously, the new temperature offset can be calculated as follows:

$$T_{Offset}^{New} = (T_{SCD30} - T_{Reference}) + T_{Offset}^{Old}$$

Where T_{Offset}^{NEW} corresponds to the new and T_{Offset}^{Old} corresponds to the old temperature offset.

After the temperature offset has been determined, it must be set to the corrected value via the digital interface. A detailed description of the relevant commands is provided in the SCD30 interface description[1]. Additionally, an

[2] Field Calibration application note. Please contact your Sensirion representative for document access.

explanatory description of setting the offset temperature is provided in the chapter *"Example: Set SCD30 to low power mode"*.

Example: Set SCD30 to low power mode

In this chapter we provide examples for the four process steps that are required to set the SCD30 sensor to the low power mode. Commands that are required for sensor communication via the digital interface are listed for I²C and Modbus protocol. Table 1 lists the parameters that are used for the working example. It is important to realize that most of the parameters are application and environment specific.

Table 1: List of parameters that are used for the working example in this chapter.
* Parameter can be defined by user
** Parameter must be determined/measured by user

Parameter	**Value**
Sampling Interval*	30 seconds
CO_2 concentration during forced recalibration**	408 ppm
Temperature offset**	2.0 °C

Step 1: Determine suitable sampling interval

In this example we will implement a sampling interval of 30 seconds. This sampling interval results in an average current of approximately 5.6 mA and a response time of 135 seconds.

Step 2: Set sampling interval

The sampling interval can be set via I2C or Modbus protocol via the following commands:

Protocol	Data to write							
I2C	Start	Write Header	Cmd MSB	Cmd LSB	Interval MSB	Interval LSB	CRC	Stop
	Start	0xC2	0x46	0x00	0x00	0x1E	0x81	Stop
Modbus	Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
	0x61	0x06	0x00	0x25	0x00	0x1E	0x11	0xA9

Step 3: Recalibration of the CO_2 output signal via forced recalibration

In this example, recalibration of the CO_2 output signal is done via forced recalibration (FRC). In order to perform a forced recalibration, the CO_2 concentration around the SCD30 must be stable and determined accurately. In this example the FRC is performed at the CO_2 concentration that corresponds to the atmospheric background level (408 ppm). Below, the corresponding I²C and Modbus commands are listed:

Protocol	Data to write							
I2C	Start	Write Header	Cmd MSB	Cmd LSB	FRC MSB	FRC LSB	CRC	Stop
	Start	0xC2	0x52	0x04	0x01	0x98	0xF5	Stop
Modbus	Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
	0x61	0x06	0x00	0x39	0x01	0x98	0x50	0x5D

Step 4: Set temperature offset

First, the temperature offset of the SCD30 must be determined. To measure the temperature offset with high precision, the SCD30 must be operated inside its final application and with the final sampling interval. In the example below, a temperature offset of 2 °C is implemented:

Protocol	Data to write							
I2C	Start	Write Header	Cmd MSB	Cmd LSB	SHT Offset MSB	SHT Offset LSB	CRC	Stop
	Start	0xC2	0x54	0x03	0x00	0xC8	0x7F	Stop
Modbus	Slave Address	Function Code	Address MSB	Address LSB	Content MSB	Content LSB	CRC LSB	CRC MSB
	0x61	0x06	0x00	0x3B	0x00	0xC8	0xF0	0x31

Appendix A: SCD 30 power consumption

The power consumption of the SCD30 sensor module consists of three main sources: the microprocessor, the IR emitter, and the IR detector. Figure 4 schematically depicts the current consumption profile of the SCD30 sensor module. While the IR detector consumes current continuously, the microprocessor and the IR emitter only consume current during a CO_2 measurement. Therefore, increasing the sampling interval to larger times allows to reduce the current consumption significantly. It is important to understand that the SCD30 sampling interval can be modified via the digital interface only. The sensor module must be permanently supplied with power, even between measurement points.

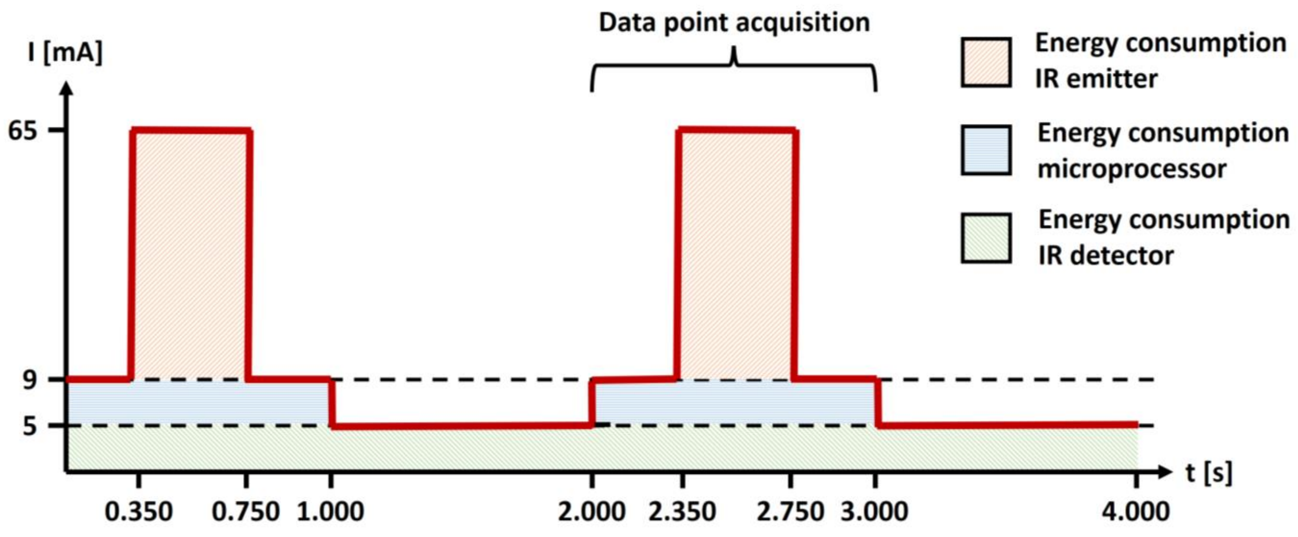

Figure 4: Schematic current consumption profile of an SCD30 sensor module with a sampling interval of 2 seconds. While the IR detector consumes current constantly, the microprocessor and the IR emitter only consume current when a data point is acquired.

Appendix B: Effect of the sampling interval on the SCD30 response time

The response time of the SCD30 CO_2 output signal is affected significantly by the sampling interval as discussed in chapter *"Finding a suitable sampling interval"*. Figure 5 depicts the CO_2 output signal for different sampling intervals after a sudden increase of the CO_2 concentration.

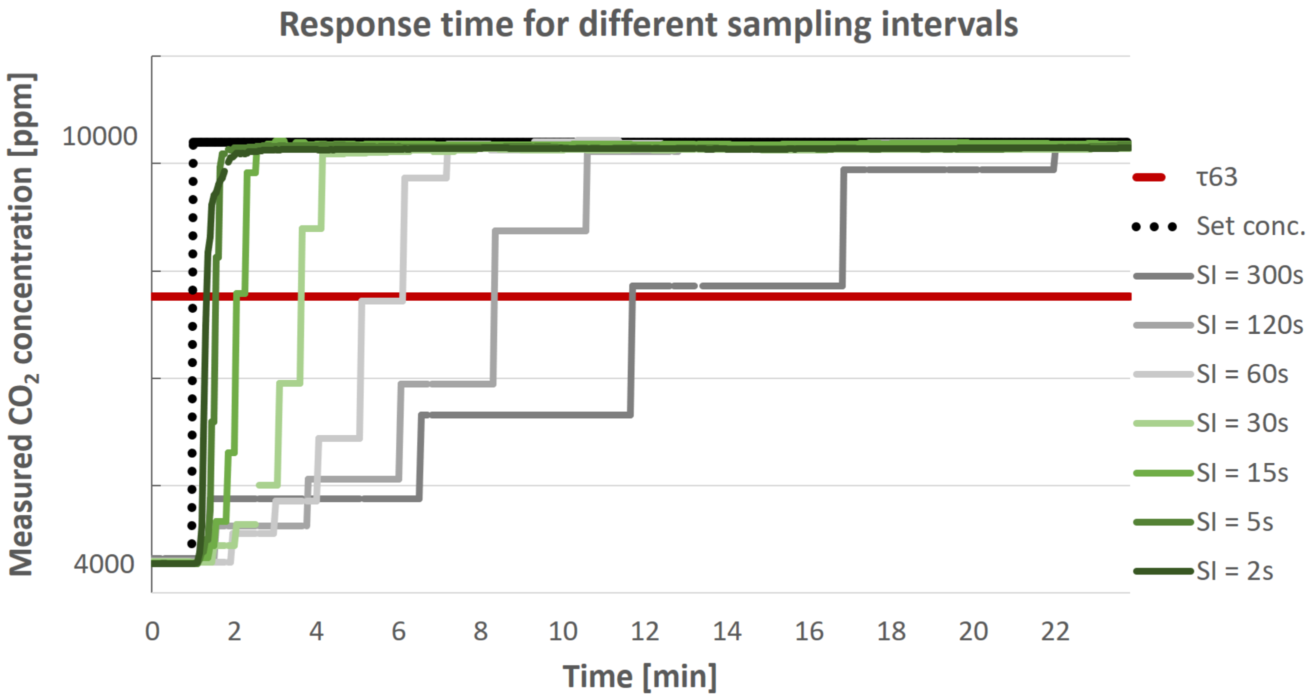

Figure 5: CO_2 output signal evolution of SCD30 sensor with different sampling intervals (SI) after a rapid change of the CO_2 concentration. The red line indicates the τ_{63} threshold and the dotted black line indicates the CO_2 concentration set point. While the response time is very low (< 40 sec.) for small sampling intervals (2 sec and 5 sec), the response time for high sampling intervals (> 60 sec) takes several minutes.

Revision History

Date	Version	Page(s)	Changes
February 2019	0.1	all	Initial version

Sensirion AG
Laubisruetistr. 50
CH-8712 Staefa ZH
Switzerland

phone: +41 44 306 40 00
fax: +41 44 306 40 30
info@sensirion.com
www.sensirion.com

Sensirion Inc., USA
phone: +1 312 690 5858
info-us@sensirion.com
www.sensirion.com

Sensirion Korea Co. Ltd.
phone: +82 31 337 7700~3
info-kr@sensirion.com
www.sensirion.co.kr

Sensirion Japan Co. Ltd.
phone: +81 3 3444 4940
info-jp@sensirion.com
www.sensirion.co.jp

Sensirion China Co. Ltd.
phone: +86 755 8252 1501
info-cn@sensirion.com
www.sensirion.com.cn

Sensirion Taiwan Co. Ltd
phone: +886 3 5506701
info@sensirion.com
www.sensirion.com

To find your local representative, please visit
www.sensirion.com/distributors