SCD4x

Breaking the size barrier in optical CO_2 sensing

Features

- Photoacoustic NDIR sensor technology PASens®
- Small form factor: 10.1 x 10.1 x 6.5 mm^3
- Reflow solderable for cost-effective assembly
- Digital I^2C interface
- Integrated temperature and humidity sensor

Product Variants

- SCD40: Base accuracy, specified measurement range 400 –2'000 ppm
- SCD41: High accuracy, specified measurement range 400 – 5'000 ppm, compatible with California Title 24[1], RESET® [2] and WELL Building Standard™ [3], features single shot operation mode

Product Summary

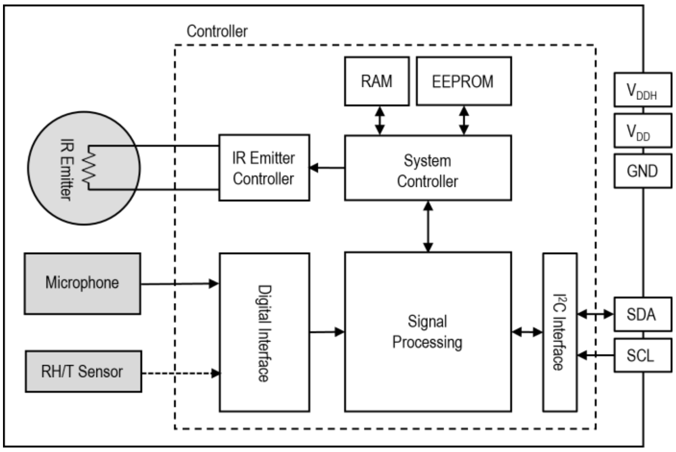
The SCD4x is Sensirion's second generation optical CO_2 sensor. This sensor builds on the photoacoustic NDIR sensing principle and Sensirion's patented PASens® and CMOSens® technology to offer high accuracy at an attractive price and small form factor. SMD assembly allows cost- and space-effective integration of the sensor combined with maximal freedom of design. On-chip signal compensation is realized with the built-in SHT4x humidity and temperature sensor.

CO_2 is a key indicator for indoor air quality (IAQ), as high levels compromise human cognitive performance and well-being. The SCD4x enables smart ventilation regulation to help improve energy efficiency and human comfort. Moreover, indoor air quality monitors and other connected devices based on the SCD4x can help maintain low CO_2 concentrations for a healthy, productive environment.

Product Overview

Products	Details
SCD40-D-R2	Base accuracy, specified range 400 – 2'000 ppm
SCD41-D-R2	High accuracy, specified range 400 – 5'000 ppm, compatible with common IAQ/building standards, single shot operation feature

Functional Block Diagram



1 2022 California Building Energy Efficiency Standards for Residential and Nonresidential Buildings
2 RESET Air Standard v2.0 Grade B
3 WELL v2 pilot, Q4 2022

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1 Sensor Performance

1.1 CO_2 Sensing Performance

Default conditions of 25 °C, 50 %RH, ambient pressure of 1013 mbar, continuous operation in periodic measurement mode (see Section 3.6.1) and 3.3 V supply voltage apply to values in the table below, unless otherwise stated.

Parameter	Conditions	Value
CO_2 output range[4]	-	0 – 40'000 ppm
SCD40 CO_2 measurement accuracy[5]	400 ppm – 2'000 ppm	±(50 ppm + 5% of reading)
SCD41 CO_2 measurement accuracy[5]	400 ppm – 1'000 ppm	±(50 ppm + 2.5% of reading)
	1'001 ppm – 2'000 ppm	±(50 ppm + 3% of reading)
	2'001 ppm – 5'000 ppm	±(40 ppm + 5% of reading)
Repeatability	Typical	±10 ppm
Response time[6]	$\tau_{63\%}$, typical, step change 400 – 2'000 ppm	60 s
Additional accuracy drift per year, starting after five years[7]	Typical, same CO_2 concentration range as sensor's specified measurement accuracy	±(5 ppm + 0.5 % of reading)

Table 1: SCD40 and SCD41 CO_2 sensor specifications

1.2 Humidity Sensing Performance

SCD4x design-in, self-heating, operation mode and the surrounding environment affects RH/T sensor performance. To achieve the specifications in **Table 2**, the temperature-offset of the SCD4x inside the customer device must be set correctly (see Section 3.7).

Parameter	Conditions	Value
Humidity measurement range	-	0 %RH – 100 %RH
Accuracy (typ.)	15 °C – 35 °C, 20 %RH – 65 %RH	±6 %RH
	-10 °C – 60 °C, 0 %RH – 100 %RH	±9 %RH
Repeatability	Typical	±0.4 %RH
Response time[6]	$\tau_{63\%}$, typical, periodic measurement mode	90 s
Accuracy drift	-	<0.25 %RH / year

Table 2: SCD4x humidity sensor specifications

1.3 Temperature Sensing Performance

SCD4x design-in, self-heating, operation mode and the surrounding environment affects RH/T sensor performance. To achieve the specifications in **Table 3**, the temperature-offset of the SCD4x inside the customer device must be set correctly (see Section 3.7)

Parameter	Conditions	Value
Temperature measurement range	-	- 10 °C – 60 °C
Accuracy (typ.)	15 °C – 35 °C	± 0.8 °C
	-10 °C – 60 °C	± 1.5 °C
Repeatability	-	± 0.1 °C
Response time[6]	$\tau_{63\%}$, typical, periodic measurement mode	120 s
Accuracy drift	-	< 0.03 °C / year

Table 3: SCD4x temperature sensor specifications

[4] Exposure to CO_2 concentrations smaller than 400 ppm can affect the accuracy of the sensor with ASC enabled.
[5] Deviation from a high-precision reference with gas mixtures having a ±2% tolerance. Rough handling, shipping, sensor assembly and long-term drift can impact sensor accuracy. Accuracy can be restored by performing forced recalibration (FRC) no less than 5 days after sensor assembly, or maintained by sensor operation with automatic self-calibration (ASC) enabled using default parameters and weekly exposure to air with CO_2 concentrations at 400 ppm. See Section 3.8 for details.
[6] Response time depends on design-in, signal update rate and environment of the sensor in the final application.
[7] Deviation is additional to standard accuracy specifications and obtained either after performing FRC or in continuous sensor operation with ASC enabled using default parameters and weekly exposure to air with CO_2 concentrations at 400 ppm. Maximum additional accuracy drift per year starting after five years estimated from stress tests is ±(5 ppm + 2% of reading). Stronger drift may occur if the sensor is not handled according to its handling instructions.

2 Specifications

2.1 Electrical Specifications

Parameter	Symbol	Conditions	Min.	Typical	Max.	Units
Supply voltage DC[8]	V_{DD}		2.4	3.3 or 5.0	5.5	V
Unloaded supply voltage ripple (peak to peak)[9]	V_{RPP}				30	mV
Peak supply current[10]	I_{peak}	V_{DD} = 3.3 V		175	205	mA
		V_{DD} = 5 V		115	137	mA
Average supply current for periodic measurement mode (1 measurement every 5 seconds)	I_{DD}	V_{DD} = 3.3 V		15	18	mA
		V_{DD} = 5 V		11	13	mA
Average supply current for low power periodic measurement mode (1 measurement every 30 seconds)	I_{DD}	V_{DD} = 3.3 V		3.2	3.5	mA
		V_{DD} = 5 V		2.8	3	mA
Average supply current for single shot mode, 1 measurement every 5 minutes (SCD41 only)[11]	I_{DD}	V_{DD} = 3.3 V		0.45	0.5	mA
		V_{DD} = 5 V		0.36	0.4	mA
Input high level voltage	V_{IH}		0.65 x V_{DD}		1 x V_{DD}	-
Input low level voltage	V_{IL}				0.3 x V_{DD}	-
Output low level voltage	V_{OL}	3 mA sink current			0.66	V

Table 4: SCD4x electrical specifications

2.2 Absolute Maximum Ratings

Stress levels beyond those listed in **Table 5** may cause permanent damage to the device. Exposure to minimum/maximum rating conditions for extended periods may affect sensor performance and device reliability.

Parameter	Conditions	Value
Temperature operating conditions		-10 – 60 °C
Humidity operating conditions[12]	Non-condensing	0 – 95 %RH
MSL Level		1
DC supply voltage		-0.3 V – 6.0 V
Max. voltage on pins SDA, SCL, GND		-0.3 V – V_{DD} + 0.3 V
Input current on pins SDA, SCL, GND		-280 mA – 100 mA
Short term storage temperature[13]		-40 °C – 70 °C
Recommended storage temperature		10 °C – 50 °C
ESD HBM (pads and metal cap)		2 kV
ESD CDM		500 V
Maintenance interval	Maintenance free when the ASC algorithm[14] is used.	None
Sensor lifetime[15]	Typical operating conditions	>10 years

Table 5: SCD4x operation conditions, lifetime and maximum ratings

[8] Supply voltage must be kept constant for stable sensor operation.
[9] Determined on the supply voltage without the load of the sensor.
[10] Refers to sustained current.
[11] On-demand measurement with adjustable interval. See Section 3.11 for details.
[12] Accuracy can be reduced at relative humidity levels lower than 10%.
[13] Short term storage refers to temporary conditions e.g., during transport.
[14] For proper function of the ASC field-calibration algorithm with default parameters, SCD4x must be exposed to air with CO_2 concentrations at 400 ppm on a weekly basis.
[15] Sensor tested over simulated lifetime of >10 years for an indoor environment mission profile.

2.3 Interface Specifications

The SCD4x comes in an LGA package (**Table 6**). Further details on the sensor's package can be found in Section 4.1. A recommended land pattern for SCD4x can be found in Section 4.2.

Name	Comments
VDD	Supply voltage
VDDH	Supply voltage IR source, must be connected to VDD on customer PCB
GND	Ground contact
SDA	I^2C serial data, bidirectional
SCL	I^2C serial clock
DNC	Do not connect, pads must be soldered to a floating pad on the customer PCB

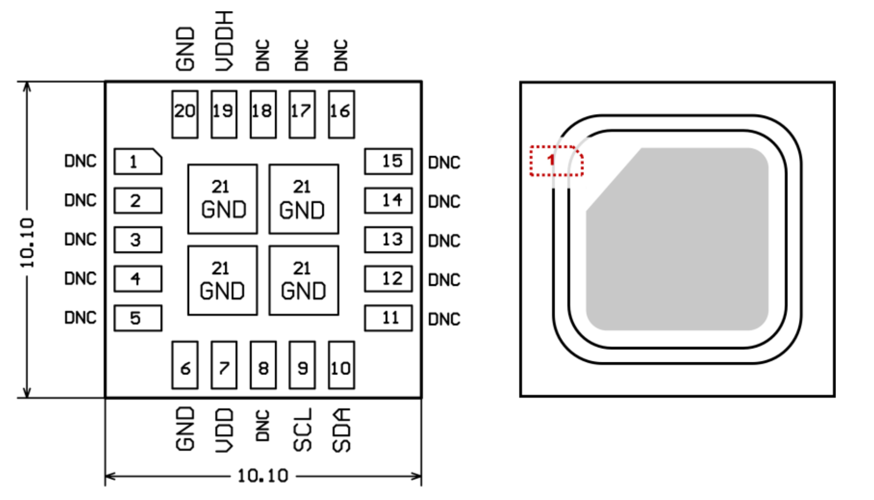


Table 6: Pin assignment (top view). The notched corner of the protection membrane serves as a polarity mark to indicate pin 1 location.

VDD and VDDH are used to supply the sensor and must always be kept at the same voltage, i.e. both should be connected to the same power supply. The combined maximum current drawn on VDD and VDDH is indicated in **Table 4**. VDD and VDDH must be connected to each other close to the sensor on the customer PCB.

For sensor operation, a low noise power supply, such as a low-dropout regulator (LDO), which can handle the peak supply current as specified in **Table 4** must be chosen. Due to the sensor's internal regulation, higher transient currents (on the timescale of microseconds) may be observed. These transient currents can be neglected in typical design-in scenarios due to the parasitic R/L/C of the leads as well as the load regulation characteristics of the supply. Additionally, to avoid interference with the sensor regulation, the supply voltage without the load of the sensor must not vary by more than 30 mV (e.g. ripples or drops caused by other loads). Operating the sensor with a separate LDO is recommended.

SCD4x uses I^2C communication based on NXP's I^2C-bus specification and user manual[16]. I^2C standard and fast mode operation are supported. SCL is used to synchronize the I^2C communication between the master (microcontroller) and the slave (sensor). The SDA pin is used to transfer data to and from the sensor. For safe communication, the timing specifications defined in the I^2C manual[16] and Section 2.4 must be met. Both SCL and SDA lines should be connected to external pull-up resistors (e.g. R_p = 10 kΩ, see **Figure 1**). To avoid signal contention, the microcontroller must only drive SDA and SCL low. For dimensioning resistor sizes, please take bus capacity and communication frequency into account (see example in Section 7.1 of NXPs I^2C Manual for more details[16]). Note that pull-up resistors may be included in the I/O circuits of microcontrollers.

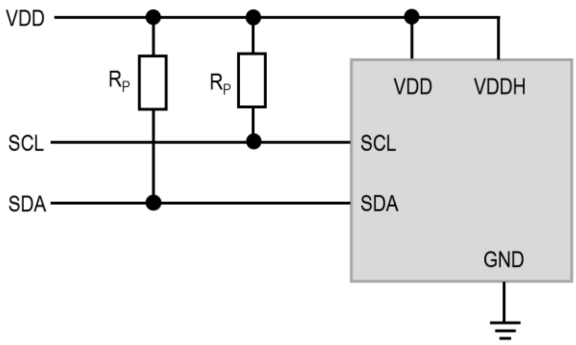


Figure 1: Typical application circuit (representative and not to scale).

[16] NXP I2C-bus specification and user manual UM10204, Rev.6, 4 April 2014

2.4 Timing Specifications

Table 7 lists the timings of the SCD4x[17].

Parameter	Condition	Min.	Max.	Unit
Power-up time	After hard reset, $V_{DD} \geq 2.25$ V	-	30	ms
Soft reset time	After re-initialization (i.e. reinit)	-	30	ms
SCL clock frequency	-	0	400	kHz

Table 7: System timing specifications.

2.5 Material Contents

The device is fully REACH and RoHS compliant.

[17] Timing specifications based on the NXP I2C-bus specification and user manual UM10204, Rev.6, 4 April 2014

3 Digital Interface Description

3.1 Power-Up and Communication Start

The sensor starts powering-up after reaching the power-up threshold voltage $V_{DD,min}$ and will take up to the maximum of the power-up time to enter the idle state. Once the idle state has been reached, it is ready to receive commands from the master. Each transmission sequence begins with a START condition (S) and ends with a STOP condition (P) as described in the I²C-bus specification.

3.2 Sensor I²C Address

SCD4x can be addressed by sending its 7-bit I²C address, given in **Table 8**, followed by an eighth bit denoting the communication direction: a "zero" indicates a "write" request, a "one" a "read" request.

SCD4x	Hex. Code
I²C address	0x62

Table 8: I²C device address

3.3 Data Type & Length

Data sent to and received from the sensor consists of a sequence of 16-bit commands and/or 16-bit words (each to be interpreted as unsigned integer with the most significant byte transmitted first). Each data word is immediately succeeded by an 8-bit CRC. In write direction it is mandatory to transmit the checksum. In read direction it is up to the master to decide if it wants to process the checksum (see Section 3.12).

3.4 Command Sequence Types

The SCD4x features four different I²C command sequence types: "*read I²C sequences*", "*write I²C sequences*", "*send I²C command*" and *"send command and fetch result"* sequences. **Figure 2** illustrates how the I²C communication for the different sequence types is built-up.

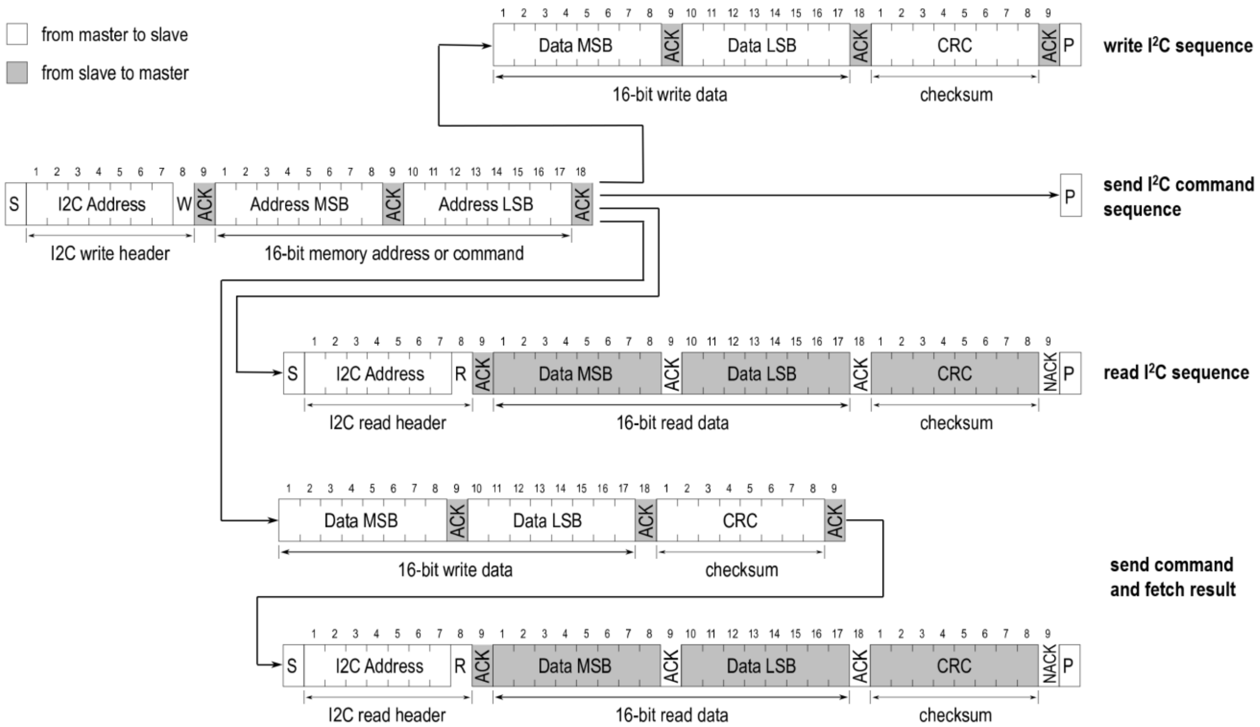


Figure 2: Command sequence types: *"write"*, *"send* command", *"read"*, and *"send command and fetch result"*

For the *"read"* or *"send command and fetch results"* sequences, after writing the address and/or data to the sensor and receiving the ACK bit from the sensor, it is required to wait for the command *execution time* (see **Table 9**) before issuing the read header. If a command execution time is specified in **Table 9**, further commands must not be sent during that command's *execution time*.

3.5 SCD4x Command Overview

An overview of the available SCD4x commands can be found in **Table 9.** A detailed description for each command can be found in the following sections. Note that some commands may also be executed while a periodic measurement mode is running.

Domain	Command	Hex. Code	I²C sequence type (see Section 3.4)	Execution	
				time [ms]	During meas.
Basic commands Section 3.6	start_periodic_measurement	0x21b1	send command	-	no
	read_measurement	0xec05	read	1	yes
	stop_periodic_measurement	0x3f86	send command	500	yes
On-chip output signal compensation Section 3.7	set_temperature_offset	0x241d	write	1	no
	get_temperature_offset	0x2318	read	1	no
	set_sensor_altitude	0x2427	write	1	no
	get_sensor_altitude	0x2322	read	1	no
	set_ambient_pressure	0xe000	write	1	yes
	get_ambient_pressure	0xe000	read	1	yes
Field calibration Section 3.8	perform_forced_recalibration	0x362f	send command and fetch result	400	no
	set_automatic_self_calibration_enabled	0x2416	write	1	no
	get_automatic_self_calibration_enabled	0x2313	read	1	no
	set_automatic_self_calibration_target	0x243a	write	1	no
	get_automatic_self_calibration_target	0x233f	read	1	no
Low power periodic measurement mode Section 3.9	start_low_power_periodic_measurement	0x21ac	send command	-	no
	get_data_ready_status	0xe4b8	read	1	yes
Advanced features Section 3.10	persist_settings	0x3615	send command	800	no
	get_serial_number	0x3682	read	1	no
	perform_self_test	0x3639	read	10’000	no
	perform_factory_reset	0x3632	send command	1’200	no
	reinit	0x3646	send command	30	no
	get_sensor_variant	0x202f	read	1	no
Single shot measurement mode (SCD41 only) Section 3.11	measure_single_shot	0x219d	send command	5’000	no
	measure_single_shot_rht_only	0x2196	send command	50	no
	power_down	0x36e0	send command	1	no
	wake_up	0x36f6	send command	30	no
	set_automatic_self_calibration_initial_period	0x2445	write	1	no
	get_automatic_self_calibration_initial_period	0x2340	read	1	no
	set_automatic_self_calibration_standard_period	0x244e	write	1	no
	get_automatic_self_calibration_standard_period	0x234b	read	1	no

Table 9: List of SCD4x sensor commands. The rightmost column (‘During meas.’) indicates whether the command can be executed while a periodic measurement mode is running.

3.6 Basic Commands

This section lists the basic SCD4x commands that are necessary to start the periodic measurement mode and subsequently read out the sensor outputs.
The typical communication sequence between the I²C master (e.g., a microcontroller) and the SCD4x sensor is as follows:

1. The sensor is powered up into the idle state.
2. The I²C master sends a *start_periodic_measurement* command. The signal update interval is 5 seconds.
3. The I²C master periodically reads out data with the *read_measurement* command.
4. When the sensor is to stop taking measurements periodically, the I²C master sends the *stop_periodic_measurement* command to return the sensor to idle mode.

While the periodic measurement mode is running, no other commands may be issued, with exception of *read_measurement*, *get_data_ready_status, stop_periodic_measurement, set_ambient_pressure* and *get_ambient_pressure.*

3.6.1 start_periodic_measurement

Description: starts the periodic measurement mode. The signal update interval is 5 seconds.

Write (hexadecimal)	**Input parameter: -**		**Response parameter: -**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x21b1	-	-	-	-	not applicable
Example: start periodic measurement					
Write *(hexadecimal)*	0x21b1 *Command*				

Table 10: start_periodic_measurement I2C sequence description

3.6.2 read_measurement

Description: reads the sensor output. The measurement data can only be read out once per signal update interval as the buffer is emptied upon read-out. If no data is available in the buffer, the sensor returns a NACK. To avoid a NACK response, the *get_data_ready_status* can be issued to check data status (see Section 3.9.2 for further details). The I²C master can abort the read transfer with a NACK followed by a STOP condition after any data byte if the user is not interested in subsequent data.

Write (hexadecimal)	**Input parameter: -**		**Response parameter:** CO_2, Temperature, Relative Humidity		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0xec05	-	-	3	$CO_2\,[\text{ppm}] = word[0]$	1
			3	$T = -45 + 175 * \frac{word[1]}{2^{16}-1}$	
			3	$RH = 100 * \frac{word[2]}{2^{16}-1}$	

Example: read sensor output (500 ppm, 25 °C, 37 %RH)						
Write *(hexadecimal)*	0xec05 *Command*					
Wait	1 ms	*command execution time*				
Response *(hexadecimal)*	0x01f4 *CO_2 = 500 ppm*	0x33 *CRC of 0x01f4*	0x6667 *Temp. = 25 °C*	0xa2 *CRC of 0x6667*	0x5eb9 *RH = 37%*	0x3c *CRC of 0x5eb9*

Table 11: read_measurement I²C sequence description

3.6.3 stop_periodic_measurement

Description: Command returns a sensor running in periodic measurement mode or low power periodic measurement mode back to the idle state, e.g. to then allow changing the sensor configuration or to save power. Note that the sensor will only respond to other commands 500 ms after the *stop_periodic_measurement* command has been issued.

Write (hexadecimal)	**Input parameter:** -		**Response parameter:** -		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x3f86	-	-	-	-	500
Example: stop periodic measurement					
Write *(hexadecimal)*	0x3f86 *Command*				

Table 12: stop_periodic_measurement I²C sequence description

3.7 On-Chip Output Signal Compensation

The SCD4x features on-chip signal compensation to automatically counteract temperature and humidity effects on CO_2 measurements. Additionally, it is possible to provide the sensor with externally obtained pressure or altitude values to enable on-board compensation of the CO_2 output signal for pressure variations. Furthermore, it is possible to improve the accuracy of the relative humidity and temperature output signal by adjusting the temperature offset parameter for the design-in of the sensor. Note that the temperature offset does not impact the accuracy of the CO_2 output.

To change or read sensor settings, the SCD4x must be in the idle state (exception: ambient pressure parameters). A typical sequence between the I²C master and the SCD4x is described as follows:

1. If the sensor is operated in a periodic measurement mode, the I²C master sends a *stop_periodic_measurement* command.
2. The I²C master sends one or several commands to get or set sensor settings / parameters.
3. If changes shall be retained across power-cycles, the *persist_settings* command must be sent (see Section 3.10.1)
4. The I²C master sends a *start_periodic_measurement* command to set the sensor in the operating mode again.

3.7.1 set_temperature_offset

Description: Setting the temperature offset of the SCD4x inside the customer device allows the user to optimize the RH and T output signal. The temperature offset can depend on several factors such as the SCD4x measurement mode, self-heating of close components, the ambient temperature and air flow. Thus, the SCD4x temperature offset should be determined after integration into the final device and under its typical operating conditions (including the operation mode to be used in the application) in thermal equilibrium. By default, the temperature offset is set to 4 °C. To save the setting to the EEPROM, the *persist_settings* (see Section 3.10.1) command may be issued. Equation (1) details how the characteristic temperature offset can be calculated using the current temperature output of the sensor (T_{SCD4x}), a reference temperature value ($T_{Reference}$), and the previous temperature offset ($T_{offset\_previous}$) obtained using the *get_temperature_offset* command (Section 3.7.2) . Recommended temperature offset values are between 0 °C and 20 °C.

$$T_{offset\_actual} = T_{SCD4x} - T_{Reference} + T_{offset\_previous} \quad (1)$$

Write (hexadecimal)	**Input parameter:** Offset temperature		**Response parameter:** -		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x241d	3	$word[0] = T_{offset}[°C] * \frac{2^{16}-1}{175}$	-	-	1
Example: set temperature offset to 5.4 °C					
Write *(hexadecimal)*	0x241d *Command*	0x07e6 *T_{offset} = 5.4 °C*	0x48 *CRC of 0x7e6*		

Table 13: set_temperature_offset I²C sequence description

3.7.2 get_temperature_offset

Write (hexadecimal)	Input parameter: -		Response parameter: Offset temperature		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x2318	-	-	3	$T_{offset}[°C] = word[0] * \frac{175}{2^{16}-1}$	1
Example: temperature offset is 6.2 °C					
Write *(hexadecimal)*	0x2318 *Command*				
Wait	1 ms	*command execution time*			
Response *(hexadecimal)*	0x0912 *T_{offset} = 6.2 °C*	0x63 *CRC of 0x0912*			

Table 14: get_temperature_offset I²C sequence description

3.7.3 set_sensor_altitude

Description: Reading and writing the sensor altitude must be done while the SCD4x is in idle mode. Typically, the sensor altitude is set once after device installation. To save the setting to the EEPROM, the *persist_settings* (see Section 3.10.1) command must be issued. The default sensor altitude value is set to 0 meters above sea level. Valid input values are between 0 – 3'000 m.

Write (hexadecimal)	Input parameter: Sensor altitude		Response parameter: -		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x2427	3	word[0] = Sensor altitude [m]	-	-	1
Example: set sensor altitude to 1'950 m					
Write *(hexadecimal)*	0x2427 *Command*	0x079e *Sensor altitude = 1'950 m*	0x09 *CRC of 0x079e*		

Table 15: set_sensor_altitude I²C sequence description

3.7.4 get_sensor_altitude

Description: The *get_sensor_altitude* command can be sent while the SCD4x is in idle mode to read out the previously saved sensor altitude value set by the *set_sensor_altitude* command.

Write (hexadecimal)	Input parameter: -		Response parameter: Sensor altitude		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x2322	-	-	3	Sensor altitude [m] = word[0]	1
Example: sensor altitude is 1'100 m					
Write *(hexadecimal)*	0x2322 *Command*				
Wait	1 ms	*command execution time*			
Response *(hexadecimal)*	0x044c *Sensor altitude = 1'100 m*	0x42 *CRC of 0x044c*			

Table 16: get_sensor_altitude I²C sequence description

3.7.5 set_ambient_pressure

Description: The *set_ambient_pressure* command can be sent during periodic measurements to enable continuous pressure compensation. Note that setting an ambient pressure overrides any pressure compensation based on a previously set sensor altitude. Use of this command is highly recommended for applications experiencing significant ambient pressure changes to ensure sensor accuracy. Valid input values are between 70'000 – 120'000 Pa. The default value is 101'300 Pa.

Write (hexadecimal)	**Input parameter:** Ambient pressure		**Response parameter:** -		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0xe000	3	word[0] = ambient P [Pa] / 100	-	-	1
Example: set ambient pressure to 98'700 Pa					
Write *(hexadecimal)*	0xe000 *Command*	0x03db *Ambient P = 98'700 Pa*	0x42 *CRC of 0x03db*		

Table 17: set_ambient_pressure I²C sequence description

3.7.6 get_ambient_pressure

Description: The *get_ambient_pressure* command can be sent during periodic measurements to read out the previously saved ambient pressure value set by the *set_ambient_pressure* command.

Write (hexadecimal)	**Input parameter:** -		**Response parameter: A**mbient pressure		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0xe000	-	-	3	ambient P [Pa] = word[0] * 100	1
Example: ambient pressure is 98'700 Pa					
Write *(hexadecimal)*	0xe000 *Command*				
Wait	1 ms	*command execution time*			
Response *(hexadecimal)*	0x03db *Ambient P = 98'700 Pa*	0xb6 *CRC of 0x03db*			

Table 18: get_ambient_pressure I²C sequence description

3.8 Field Calibration

To achieve high initial and excellent long-term accuracy, the SCD4x includes two field calibration features: Forced recalibration (FRC) and automatic self-calibration (ASC).

The ASC enables excellent long-term stability of SCD4x without the need for regular user intervention. The algorithm leverages the sensor's measurement history and the assumption of exposure of the sensor to a known minimum background CO_2 concentration at least once over a period of cumulative operation. By default, the ASC algorithm assumes that the sensor is exposed to outdoor fresh air at 400 ppm CO_2 concentration at least once per week of accumulated operation using one of the following measurement modes for at least 4 hours without interruption at a time: periodic measurement mode (Section 3.6), low power periodic measurement mode (Section 3.9) or single shot mode with a measurement interval of 5 minutes (SCD41 only, see Section 3.11).

Performing FRC restores high accuracy by providing the SCD4x with an externally obtained CO_2 reference value. FRC can be applied to quickly correct the sensor's output, e.g. if it is not possible to wait for and/or rely on ASC.

3.8.1 perform_forced_recalibration

Description: To successfully conduct an accurate FRC, the following steps need to be carried out:

1. Operate the SCD4x in the operation mode later used for normal sensor operation (e.g. periodic measurement) for at least 3 minutes in an environment with a homogenous and constant CO_2 concentration. The sensor must be operated at the voltage desired for the application when performing the FRC sequence.
2. Issue the *stop_periodic_measurement* command. Wait 500 ms for the command to complete.
3. Issue the *perform_forced_recalibration* command and optionally read out the FRC correction (i.e. the magnitude of the correction) after waiting for 400 ms for the command to complete. A return value of 0xffff indicates that the FRC has failed because the sensor was not operated before sending the command.

Write (hexadecimal)	**Input parameter:** Target CO_2 concentration		**Response parameter:** FRC-correction		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x362f	3	word[0] = Target concentration [ppm CO_2]	3	FRC correction [ppm CO_2] = word[0] – 0x8000 word[0] = 0xffff in case of failed FRC	400

Example: perform forced recalibration, reference CO_2 concentration is 480 ppm			
Write *(hexadecimal)*	0x362f *Command*	0x01e0 *Input: 480 ppm*	0xb4 *CRC of 0x01e0*
Wait	400 ms	*command execution time*	
Response *(hexadecimal)*	0x7fce *Response: - 50 ppm*	0x7b *CRC of 0x7fce*	

Table 19: perform_forced_recalibration I²C sequence description

3.8.2 set_automatic_self_calibration_enabled

Description: sets the current state (enabled / disabled) of the ASC. By default, ASC is enabled. To save the setting to the EEPROM, the *persist_settings* (see Section 3.10.1) command must be issued.

Write (hexadecimal)	**Input parameter:** ASC enabled		**Response parameter:** -		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x2416	3	word[0] = 1 → ASC enabled word[0] = 0 → ASC disabled	-	-	1

Example: set ASC status: enabled			
Write *(hexadecimal)*	0x2416 *Command*	0x0001 *ASC enabled*	0xb0 *CRC of 0x0001*

Table 20: set_automatic_self_calibration_enabled I²C sequence description.

3.8.3 get_automatic_self_calibration_enabled

Write (hexadecimal)	**Input parameter:** -		**Response parameter:** ASC enabled		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x2313	-	-	3	word[0] = 1 → ASC enabled word[0] = 0 → ASC disabled	1

Example: read ASC status: disabled		
Write *(hexadecimal)*	0x2313 *Command*	
Wait	1 ms	*command execution time*
Response *(hexadecimal)*	0x0000 *ASC disabled*	0x81 *CRC of 0x0000*

Table 21: get_automatic_self_calibration_enabled I²C sequence description

3.8.4 set_automatic_self_calibration_target

Description: sets the value of the ASC baseline target, i.e. the CO_2 concentration in ppm which the ASC algorithm will assume as lower-bound background to which the SCD4x is exposed to regularly within one ASC period of operation. To save the setting to the EEPROM, the *persist_settings* (see Section 3.10.1) command must be issued subsequently.

Write (hexadecimal)	**Input parameter:** -		**Response parameter:**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x243a	3	word[0] = ASC target [ppm CO_2]	-	-	1

Example: Set ASC target to 435 ppm			
Write *(hexadecimal)*	0x243a *Command*	0x01b3 *ASC target = 435 ppm*	0x99 *CRC of 0x01b3*

Table 22: set_automatic_self_calibration_target I²C sequence description

3.8.5 get_automatic_self_calibration_target

Description: reads out the ASC baseline target concentration parameter. The factory default value is 400 ppm.

Write (hexadecimal)	**Input parameter: -**		**Response parameter:** ASC baseline target		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x233f	-	-	3	word[0] = ASC target [ppm CO_2]	1

Example: ASC target is 420 ppm		
Write *(hexadecimal)*	0x233f *Command*	
Wait	1 ms	*command execution time*
Response *(hexadecimal)*	0x01a4 *ASC target is 420 ppm*	0x4d *CRC of 0x01a4*

Table 23: get_automatic_self_calibration_target I²C sequence description

3.9 Low Power Periodic Measurement Mode

To enable use-cases with a constrained power budget, the SCD4x features a low power periodic measurement mode with a signal update interval of approximately 30 seconds. The low power periodic measurement mode is initiated using the *start_low_power_periodic_measurement* command and read-out in a similar manner as the periodic measurement mode using the *read_measurement* command. Please consult Section 3.6.2 for further instructions.

To periodically check whether a new measurement result is available for read out, the *get_data_ready_status* command (Section 3.9.2) can be used to synchronize to the sensor's internal measurement interval as an alternative to relying on the ACK/NACK status of the *read_measurement_command* (Section 3.6.2)

3.9.1 start_low_power_periodic_measurement

Description: starts the low power periodic measurement mode. The signal update interval is approximately 30 seconds.

Write (hexadecimal)	**Input parameter: -**		**Response parameter: -**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x21ac	-	-	-	-	not applicable

Example: start low power periodic measurement	
Write *(hexadecimal)*	0x21ac *Command*

Table 24: start_low_power_periodic_measurement I²C sequence description

3.9.2 get_data_ready_status

Description: polls the sensor for whether data from a periodic or single shot measurement is ready to be read out.

Write (hexadecimal)	**Input parameter: -**		**Response parameter:** data ready status		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0xe4b8	-	-	3	If the least significant 11 bits of word[0] are: 0 → data not ready else → data ready for read-out	1

Example: read data ready status: data not ready		
Write *(hexadecimal)*	0xe4b8 *Command*	
Wait	1 ms	*command execution time*
Response *(hexadecimal)*	0x8000 *Least significant 11 bits are 0 → data not ready*	0xa2 *CRC of 0x8000*

Table 25: get_data_ready_status I²C sequence description

3.10 Advanced Features

3.10.1 persist_settings

Description: Configuration settings such as the temperature offset, sensor altitude and the ASC enabled/disabled parameters are by default stored in the volatile memory (RAM) only. The *persist_settings* command stores the current configuration in the EEPROM of the SCD4x, ensuring the current settings persist after power-cycling. To avoid unnecessary wear of the EEPROM, the *persist_settings* command should only be sent following configuration changes whose persistence is required. The EEPROM is guaranteed to withstand at least 2000 write cycles. Note that field calibration history (i.e. FRC and ASC, see Section 3.8) is automatically stored in a separate EEPROM dimensioned for the specified sensor lifetime when operated continuously in either periodic measurement mode (see Section 3.5.1), low power periodic measurement mode (see Section 3.9) or single shot mode with 5 minute measurement interval (SCD41 only, see Section 3.11).

Write (hexadecimal)	**Input parameter: -**		**Response parameter: -**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x3615	-	-	-	-	800

Example: persist settings	
Write *(hexadecimal)*	0x3615 *Command*

Table 26: persist_settings I²C sequence description

3.10.2 get_serial_number

Description: Reading out the serial number can be used to identify the chip and to verify the presence of the sensor. The *get_serial_number* command returns 3 words, and every word is followed by an 8-bit CRC checksum. Together, the 3 words constitute a unique serial number with a length of 48 bits (in big endian format).

Write (hexadecimal)	**Input parameter:** -		**Response parameter:** serial number		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x3682	-	-	9	Serial number = word[0] << 32 | word[1] << 16 | word[2]	1

Example: serial number is 273’325’796’834’238

Write *(hexadecimal)*	0x3682 *Command*					
Wait	1 ms	*command execution time*				
Response *(hexadecimal)*	0xf896 *word[0]*	0x31 *CRC of 0xf896*	0x9f07 *word[1]*	0xc2 *CRC of 0x9f07*	0x3bbe *word[2]*	0x89 *CRC of 0x3bbe*

Table 27: get_serial_number I²C sequence description

3.10.3 perform_self_test

Description: The *perform_self_test* command can be used as an end-of-line test to check the sensor functionality.

Write (hexadecimal)	**Input parameter:** -		**Response parameter:** sensor status		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x3639	-	-	3	word[0] = 0 → no malfunction detected word[0] ≠ 0 → malfunction detected	10’000

Example: perform self-test, no malfunction detected

Write *(hexadecimal)*	0x3639 *Command*	
Wait	10000 ms	*command execution time*
Response *(hexadecimal)*	0x0000 *No malfunction detected*	0x81 *CRC of 0x0000*

Table 28: perform_self_test I²C sequence description

3.10.4 perfom_factory_reset

Description: The *perform_factory_reset* command resets all configuration settings stored in the EEPROM and erases the FRC and ASC algorithm history.

Write (hexadecimal)	**Input parameter:** -		**Response parameter:** -		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x3632	-	-	-	-	1’200

Example: perform factory reset

Write *(hexadecimal)*	0x3632 *Command*

Table 29: perform_factory_reset I²C sequence description

3.10.5 reinit

Description: The *reinit* command reinitializes the sensor by reloading user settings from EEPROM. The sensor must be in the idle state before sending the *reinit* command. If the *reinit* command does not trigger the desired re-initialization, a power-cycle should be applied to the SCD4x.

Write (hexadecimal)	**Input parameter: -**		**Response parameter: -**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x3646	-	-	-	-	30
Example: reinit					
Write	0x3646				
(hexadecimal)	*Command*				

Table 30: reinit I²C sequence description

3.10.6 get_sensor_variant

Description: reads out the SCD4x sensor variant (e.g. SCD40 or SCD41).

Write (hexadecimal)	**Input parameter: -**		**Response parameter:** sensor variant		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x202f	-	-	3	Word[0]: Bits[15…12] = 0000 → SCD40 Bits[15…12] = 0001 → SCD41	1
Write	0x202f				
(hexadecimal)	*Command*				
Wait	1 ms	*command execution time*			
Example: sensor variant is SCD41. Response bits 0…11 may differ from this example					
Response	0x1440	0x51			
(hexadecimal)	*Product version = SCD41*	*CRC of 0x1440*			
Example: sensor variant is SCD40. Response bits 0…11 may differ from this example					
Response	0x0440	0x3F			
(hexadecimal)	*Product version = SCD40*	*CRC of 0x0440*			

Table 31: get_sensor_variant I²C sequence description

3.11 Single Shot Measurement Mode (SCD41 Only)

The SCD41 additionally features a single shot measurement mode for on-demand measurements.
The typical communication sequence is as follows:

1. The sensor is powered up with the *wake_up* command if previously powered down using the *power_down* command.
2. The I²C master sends a *measure_single_shot* command and waits for the indicated *max. command duration* time.
3. The I²C master reads out data with the *read_measurement* command (3.6.2) after the specified *max. command duration* time.
4. Repeat steps 2–3 as required by the application.
5. If desired, power down the sensor with the *power_down* command.

To reduce noise levels, the I²C master can perform several single shot measurements in a row and average the CO_2 output values. Note: The fastest possible sampling interval for single shot measurements is 5 seconds.

The ASC is enabled by default in single shot operation and optimized for single shot measurements performed every 5 minutes. Longer or shorter single shot measurement intervals will result in less or more frequent ASC corrections, respectively. To adapt the ASC parameters for measurement intervals other than 5 minutes, the ASC initial and standard period length parameters can be adjusted (see relevant commands in following subsections and relevant supporting documentation[18]). The standard period represents the cumulative duration of the sensor in measurement mode, tracked in blocks of 4 hours, periodically triggering automatic self-calibration. If operated for the very first time, or following a *perform_factory_reset* command, the shorter initial period parameter is used exactly and only once.

Note that, for single shot operation with ASC enabled and measurement intervals of less than 5 minutes, the lifetime of EEPROM used by the ASC is reduced proportionally.

To further reduce the sensor's power consumption, the sensor may be power cycled between measurements either by cutting/re-applying the supply and I²C voltages or by using the *power_down/wake_up* commands. Note that for power-cycled single shot operation, ASC functionality is not available in either case.

3.11.1 measure_single_shot

Description: on-demand measurement of CO_2 concentration, relative humidity and temperature. The sensor output is read out by using the *read_measurement* command (Section 3.6.2).

Write (hexadecimal)	**Input parameter: -**		**Response parameter: -**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x219d	-	-	-	-	5'000
Example: measure single shot					
Write *(hexadecimal)*	0x219d *Command*				

Table 32: measure_single_shot I²C sequence description

[18] More information on ASC settings and SCD4x low power modes can be found in the application note on "Low Power Operation SCD4x"

3.11.2 measure_single_shot_rht_only

Description: on-demand measurement of relative humidity and temperature only, significantly reduces power consumption. The sensor output is read out by using the *read_measurement* command (Section 3.6.2). CO_2 output is returned as 0 ppm.

Write (hexadecimal)	**Input parameter: -**		**Response parameter: -**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x2196	-	-	-	-	50
Example: measure single shot, RH and T output only					
Write *(hexadecimal)*	0x2196 *Command*				

Table 33: measure_single_shot_rht_only I²C sequence description

3.11.3 power_down

Description: put the sensor from idle to sleep to reduce current consumption. Can be used to power down when operating the sensor in power-cycled single shot mode.

Write (hexadecimal)	**Input parameter: -**		**Response parameter: -**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x36e0	-	-	-	-	1
Example: power down the sensor					
Write *(hexadecimal)*	0x36e0 *Command*				

Table 34: power_down I²C sequence description

3.11.4 wake_up

Description: wake up the sensor from sleep mode into idle mode. Note that the SCD4x does not acknowledge the *wake_up* command. The sensor's idle state after wake up can be verified by reading out the serial number (Section 3.10.2).

Write (hexadecimal)	**Input parameter: -**		**Response parameter: -**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x36f6	-	-	-	-	30
Example: wake up the sensor					
Write *(hexadecimal)*	0x36f6 *Command*				

Table 35: wake_up I²C sequence description

3.11.5 set_automatic_self_calibration_initial_period

Description: sets the duration of the initial period for ASC correction (in hours). By default, the initial period for ASC correction is 44 hours. Allowed values are integer multiples of 4 hours. A value of 0 results in an immediate correction. To save the setting to the EEPROM, the *persist_settings* (see Section 3.10.1) command must be issued.

Note: For single shot operation, this parameter always assumes a measurement interval of 5 minutes, counting the number of single shots to calculate elapsed time. If single shot measurements are taken more / less frequently than once every 5 minutes, this parameter must be scaled accordingly to achieve the intended period in hours (e.g. for a 10-minute measurement interval, the scaled parameter value is obtained by multiplying the intended period in hours by 0.5).

Write (hexadecimal)	**Input parameter:** ASC initial period		**Response parameter: -**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x2445	3	word[0] = ASC initial period [hours]	-	-	1
Example: write ASC initial period of 76 hours					
Write *(hexadecimal)*	0x2445 *Command*	0x004c *Initial period 76 hours*	0xc1 *CRC of 0x004c*		

Table 36: set_automatic_self_calibration_initial_period I²C sequence description

3.11.6 get_automatic_self_calibration_initial_period

Write (hexadecimal)	**Input parameter: -**		**Response parameter:** ASC initial period		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x2340	-	-	3	ASC initial period [hours] = word[0]	1
Example: read ASC initial period of 76 hours					
Write *(hexadecimal)*	0x2340 *Command*				
Wait	1 ms	*command execution time*			
Response *(hexadecimal)*	0x004c *76 hours*	0xc1 *CRC of 0x004c*			

Table 37: get_automatic_self_calibration_initial_period I²C sequence description

3.11.7 set_automatic_self_calibration_standard_period

Description: sets the standard period for ASC correction (in hours). By default, the standard period for ASC correction is 156 hours. Allowed values are integer multiples of 4 hours. Note: a value of 0 results in an immediate correction. To save the setting to the EEPROM, the *persist_settings* (see Section 3.10.1) command must be issued.

Note: For single shot operation, this parameter always assumes a measurement interval of 5 minutes, counting the number of single shots to calculate elapsed time. If single shot measurements are taken more / less frequently than once every 5 minutes, this parameter must be scaled accordingly to achieve the intended period in hours (e.g. for a 10-minute measurement interval, the scaled parameter value is obtained by multiplying the intended period in hours by 0.5).

Write (hexadecimal)	**Input parameter:** ASC standard period		**Response parameter: -**		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x244e	3	word[0] = ASC standard period [hours]	-	-	1
Example: set automatic self-calibration standard period of 156 hours					
Write	0x244e	0x009c	0xc5		
(hexadecimal)	*Command*	*Standard period 156 hours*	*CRC of 0x009c*		

Table 38: set_automatic_self_calibration_standard_period I²C sequence description

3.11.8 get_automatic_self_calibration_standard_period

Write (hexadecimal)	**Input parameter: -**		**Response parameter:** ASC standard period		Max. command duration [ms]
	length [bytes]	signal conversion	length [bytes]	signal conversion	
0x234b	-	-	3	word[0] = ASC standard period [hours]	1
Example: read ASC standard period of 156 hours					
Write	0x234b				
(hexadecimal)	*Command*				
Wait	1 ms	*command execution time*			
Response	0x009c	0xc5			
(hexadecimal)	*Standard period 156 hours*	*CRC of 0x009c*			

Table 39: get_automatic_self_calibration_standard_period I²C sequence description

3.12 Checksum Calculation

The 8-bit CRC checksum transmitted after each data word is generated by a CRC algorithm. Its properties are displayed in **Table 40**. The CRC covers the contents of the two previously transmitted data bytes. To calculate the checksum only these two previously transmitted data bytes are used. Note that command words are not followed by CRC.

Property	Value
Name	CRC-8
Width	8 bit
Protected Data	read and/or write data
Polynomial	0x31 ($x^8 + x^5 + x^4 + 1$)
Initialization	0xff
Reflect input	False
Reflect output	False
Final XOR	0x00
Examples	CRC (0xbeef) = 0x92

Example code (C/C++)

```c
#define CRC8_POLYNOMIAL 0x31
#define CRC8_INIT 0xff

uint8_t sensirion_common_generate_crc(const uint8_t* data, uint16_t count) {
   uint16_t current_byte;
   uint8_t crc = CRC8_INIT;
   uint8_t crc_bit;
   /* calculates 8-Bit checksum with given polynomial */
   for (current_byte = 0; current_byte < count; ++current_byte) {
      crc ^= (data[current_byte]);
      for (crc_bit = 8; crc_bit > 0; --crc_bit) {
         if (crc & 0x80)
            crc = (crc << 1) ^ CRC8_POLYNOMIAL;
         else
            crc = (crc << 1);
      }
   }
   return crc;
}
```

Table 40: I²C CRC properties

4 Mechanical Specifications

4.1 Package Outline

Figure 3 schematically displays the sensor's package outline, as well as key nominal dimensions and their tolerances in millimeters. A circular mark and a notched corner of the protective membrane serve as polarity marks to indicate the location of pin 1. The white protective membrane on top of the sensor must not be removed or tampered with to ensure proper sensor operation. The weight of the sensor is approx. 0.6 g.

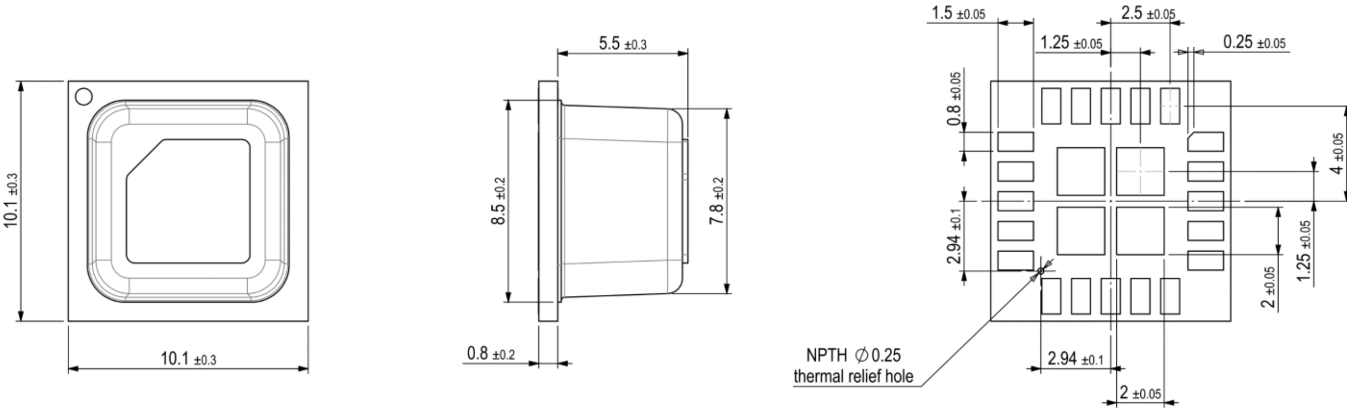


Figure 3: Sensor package dimensions of SCD4x: top, side and bottom view (left to right, projection method 1). All dimensions in millimeters.

4.2 Land Pattern Recommendation

Recommended land pattern, solder paste, and solder mask are shown in **Figure 4**. The exact mask geometries, distances and stencil thicknesses must be adapted to the customer soldering processes. In any case, the keep-free area around the thermal relief hole of the sensor must be respected.

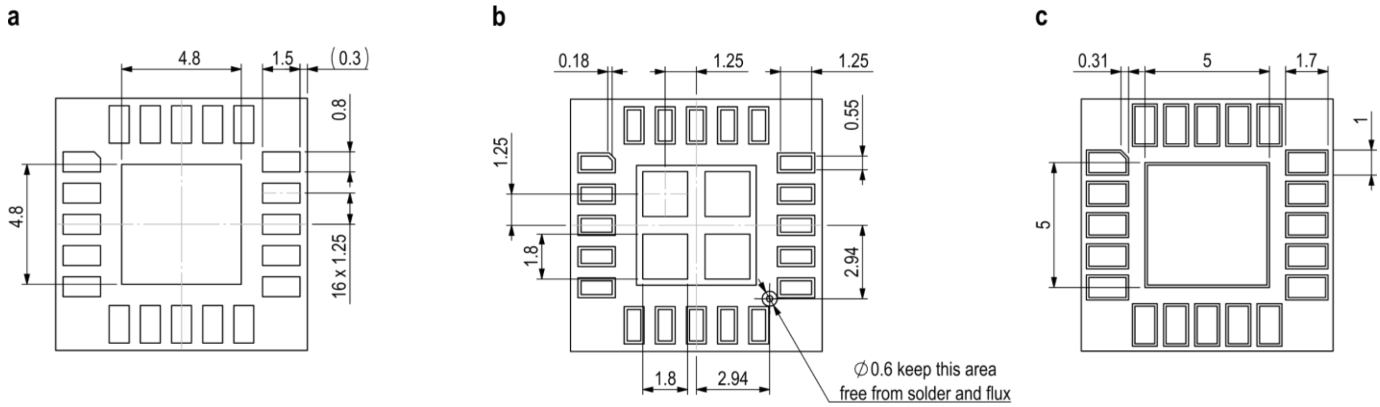
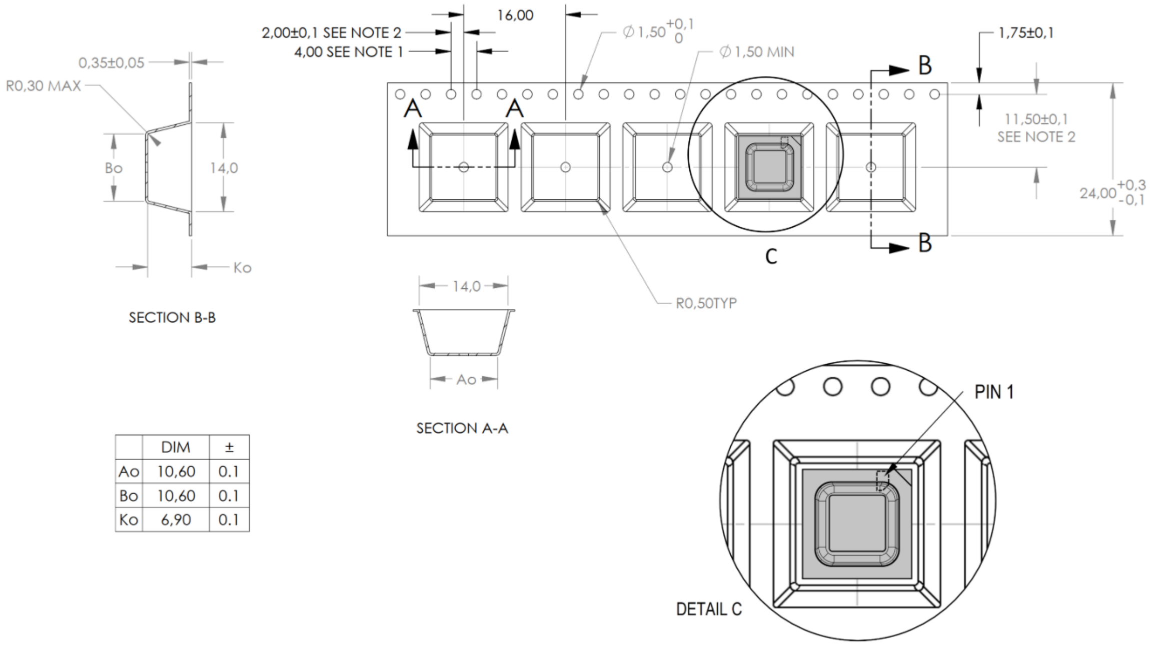


Figure 4: Recommended SCD4x footprint (top view): landing pads (**a**), solder paste (**b**) and solder mask (**c**). All dimensions in millimeters.

4.3 Tape & Reel Package

Figure 5 details the tape and reel package specifications. Reels are 7 inches and 13 inches in diameter for the 60-piece and 600-piece package sizes, respectively.



	DIM	±
Ao	10,60	0.1
Bo	10,60	0.1
Ko	6,90	0.1

Figure 5: Technical drawing of the packaging tape with sensor orientation in tape. In the drawing, header tape is to the right and trailer tape to the left. All dimensions in millimeters.

4.4 Moisture Sensitivity Level

Sensirion SCD4x sensors must be treated according to Moisture Sensitivity Level 1 (MSL1) as per IPC/JEDEC J-STD-033B1. The manufacturing floor time (out of bag) at the customer's end is not limited under normal factory conditions (≤30 °C and 85 %RH). It is recommended to process the sensors within one year of the date of delivery. Exposure to moisture levels or solder reflow temperatures which exceed the limits as stated in this document can result in yield loss and reliability degradation[19].

[19] More information on SCD4x packing and storage can be found in the user guide "Handling Instructions SCD4x"

4.5 Soldering Instructions

The sensors are designed to withstand a soldering profile based on IPC/JEDEC J-STD-020, with a maximum peak temperature of 245 °C up to 30 sec and Pb-free assembly in IR/Convection reflow ovens. See **Table 41** for more details.

Note that due to the size and shape of the SCD4x sensor, significant temperature differences across the sensor element can occur during reflow soldering. Specifically, the temperature within the sensor cap can be higher than the temperature measured at the pad using usual temperature monitoring methods. Care must be taken that a temperature of 245°C is not exceeded at any time in any part of the sensor.

The SCD4x is not compatible with vapor phase reflow soldering. The dust cover on top of the cap must not be removed or wetted with any liquid. Do not apply extra flux during the reflow soldering nor reflow solder more than once. Do not apply any board wash process step subsequently to the reflow soldering[20].

Minor temporary accuracy deviations of the CO_2 reading can result from the reflow soldering of the SCD4x. Full sensor accuracy is restored after at most five days after the soldering process, independently of whether the sensor is operated or not.

Average ramp-up rate	< 3 °C / second
Liquid phase ▪ T_L ▪ t_L	 > 220 °C < 60 seconds
Peak temperature ▪ T_P ▪ t_P	 ≤ 245°C < 30 seconds
Ramp-down rate	< 4 °C / second for temperature > T_L

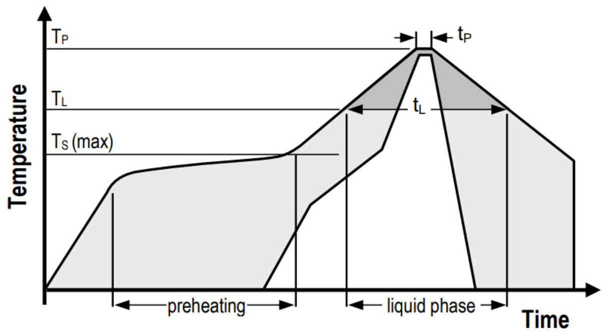


Table 41: Soldering profile parameters

4.6 Traceability and Identification

All SCD4x sensors have a distinct electronic serial number for identification and traceability (see Section 3.10.2). The serial number can be decoded by Sensirion only and allows for tracking through production, calibration, and testing.

All SCD4x sensors include a laser marking on the sidewall of the sensor cap. The laser marking contains the product variant (i.e., SCD40 or SCD41) and the product serial number within a data matrix (**Figure 6**).

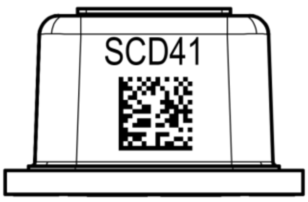


Figure 6: Technical drawing of the laser marking of product type and data matrix on the sidewall of the sensor cap.

[20] More information on SCD4x reflow soldering can be found in the user guide "Handling Instructions SCD4x"

5 Ordering Information

Use the part names and product numbers shown in **Table 42** when ordering the SCD4x CO_2 sensor. For the latest product information and local distributors, please visit the Sensirion website.

Part Name	Description	Ordering quantity (pcs)	Product Number
SCD40-D-R1	SCD40 CO2 sensor SMD component as reel, I2C	60 sensors per reel	3.000.496
SCD40-D-R2	SCD40 CO2 sensor SMD component as reel, I2C	600 sensors per reel	3.000.521
SCD41-D-R1	SCD41 CO2 sensor SMD component as reel, I2C	60 sensors per reel	3.000.960
SCD41-D-R2	SCD41 CO2 sensor SMD component as reel, I2C	600 sensors per reel	3.000.961
SEK-SCD41-Sensor	SEK-SCD41-Sensor set; SCD41 on development board with cables	1	3.000.455
SEK-SensorBridge	Sensor Bridge to connect SEK-SCD41-Sensor to computer	1	3.000.124

Table 42: Active part names and product numbers for ordering SCD4x

5.1 Historical Information

The parts / product numbers of the SCD4x product family shown in **Table 43** are obsolete.

Period Active	Product Number	Note
Before 01.08.2023	3.000.497	For applicable specifications, see Version 1.3 of the SCD4x Datasheet
Before 01.08.2023	3.000.498	For applicable specifications, see Version 1.3 of the SCD4x Datasheet

Table 43: Obsolete ordering information

6 Revision History

Date	Version	Page(s)	Changes
January 2021	1	all	Initial release
April 2021	1.1	16 - 17	Adjustment max. command time self-test (Section 3.9) and single shot (Section 3.10), minor revisions on other pages
May 2022	1.2	3 12 18 22 all	Clarification on additional sensor accuracy drift (Table 1) Clarification of set_ambient_pressure command description (Section 3.7.5) Addition of power_down and wake_up commands (Section 3.11) Addition of minor temporary accuracy deviation after reflow soldering (Section 4.5) Minor editorial revisions
September 2022	1.3	1,22 All	Correction of hyperlink Minor editorial revisions
February 2023	1.4	3 4 5 6 7 8 10 11 12 17 19 20 22 24 All	Updated SCD41 accuracy values, updated drift parameters and drift conditions (Table 1), correction of tolerance in footnote #2, clarification of footnotes #2, 4 and 5 Clarification of operation mode per average supply current (Table 4), additional information on ESD HBM (Table 5), additional footnote #8, clarification of footnotes #7 and 12 Clarification of recommendations on power supply for sensor operation (Section 2.3) Correction of power-up time and soft reset time, increase of maximum SCL clock frequency to 400 kHz (Section 2.4) Minor editorial revisions for clarification (Section 3.1) Addition of get_ambient_pressure, set_automatic_self_calibration_initial_period, get_automatic_self_calibration_initial_period, set_automatic_self_calibration_standard_period, get_automatic_self_calibration_standard_period ~~and set_automatic_self_calibration_target~~ commands (Table 9), correction of reinit and wake_up execution times (Section 3.4) Addition of recommended temperature offset range, formula correction of signal conversion (Section 3.6.1) Formula correction of signal conversion (Section 3.6.2), addition of valid sensor altitude input values (Section 3.6.3) Addition of valid ambient pressure input values to set_ambient_pressure command (Section 3.6.5) and addition of get_ambient_pressure command (Section 3.6.6) Correction of reinit max. command duration (Section 3.9.5), clarification of typical communication sequence for single shot measurement mode (Section 3.10) Correction of wake_up max. command duration (Section 3.10.4), addition of set_automatic_self_calibration_initial_period (Section 3.10.5) and get_automatic_self_calibration_initial_period commands (Section 3.10.6) Addition of set_automatic_self_calibration_standard_period command (Section 3.10.7) and get_automatic_self_calibration_standard_period command (Section 3.10.8) Additional information on white protection membrane (Section 4.1) Increase of peak reflow soldering temperature to 245°C, clarification of soldering guidance (Section 4.5), addition of information concerning product laser marking (Section 4.6) Minor editorial revisions
July 2023	1.5	4 15 19, 20 22 25 All	Clarified description of supply voltage ripple specification (Section 2, Table 4) Addition of description for get_data_ready_status command (Section 3.8.2) Clarification on ASC availability in power-cycled single shot operation (Section 3.10), Addition of clarification on ASC period parameter scaling for single shot operation (Sections 3.10.5 and 3.10.7) Moved dimensions into Figure 3, removed separate table with dimensions (Section 4.1) Updated product numbers for SCD41, addition of historical ordering information (Section 5) Minor editorial revisions
June 2024	1.6	1 3 4	Updated visuals and product summary, corrected block diagram, added footnotes #1-3 Clarification of default conditions, clarification of conditions for response time specification and description of drift specification (Table 1), clarified measurement mode condition for RH/T response time specification and moved previous footnote #5 into prose text (Sections 1.2 and 1.3), clarification of footnotes #5-7(prev. footnotes 2-4). Changed moisture sensitivity level specification to MSL Level 1 (Section 2.2, Table 5) Clarification of footnote #15 (prev. footnote 11)

		5	Clarification of recommendations on power supply for sensor operation and of I^2C specification (Section 2.3)
		7	Moved Table 8 into separate new sub-section clarifying sensor I^2C address (Section 3.2)
		8	Addition of set_automatic_self_calibration_target, get_automatic_self_calibration_target and get_sensor_variant commands to Table 9 (Section 3.5)
		9	Clarified typical communication sequence description (Section 3.6)
		10	Clarified description of stop_periodic_measurement command (Section 3.6.3)
			Clarified description of on-chip output signal compensation (Section 3.7) and set_temperature_offset command (Section 3.7.1)
		13	Clarified and expanded information on ASC functionality and conditions for use with default parameters (Section 3.8)
		14	Addition of set_automatic_self_calibration_target command (Section 3.8.4)
		15	Addition of get_automatic_self_calibration_target command (Section 3.8.5)
		16	Clarified note on EEPROM lifetime conditions for operation with ASC (Section 3.10.1)
		18	Addition of get_sensor_variant command (Section 3.10.6)
			Addition of note on shortest possible single shot measurement interval, clarified impact of single shot measurement interval on ASC functionality and EEPROM lifetime, removed recommendation to discard initial single shot measurement after power cycle (Section 3.11)
		21	Clarified note on ASC initial period parameter adaption based on single shot measurement interval (Section 3.11.5)
		22	Clarified note on ASC standard period parameter adaption based on single shot measurement interval (Section 3.11.7)
		24	Clarified note on polarity marking of the sensor, updated Figure 3 to add bottom view with respective dimensions (Section 4.1)
			Addition of note on sensor thermal relief hole and respective keep free area, updated Figure 4 for clarity (Section 4.2)
		25	Addition of reel diameters (Section 4.3).
			Updated moisture sensitivity level specification from MSL3 to MSL1, adapted out of bag manufacturing floor time conditions in accordance with MSL1, removed table specifying baking conditions for MSL3 (Section 4.4)
		All	Minor editorial revisions

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