SENSIRION

Datasheet – STCC4 CO_2 Sensor

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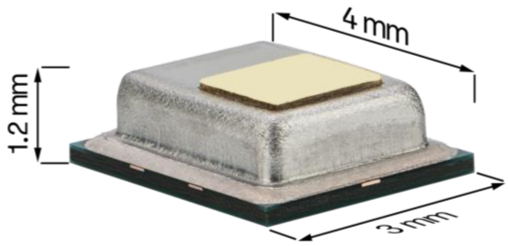
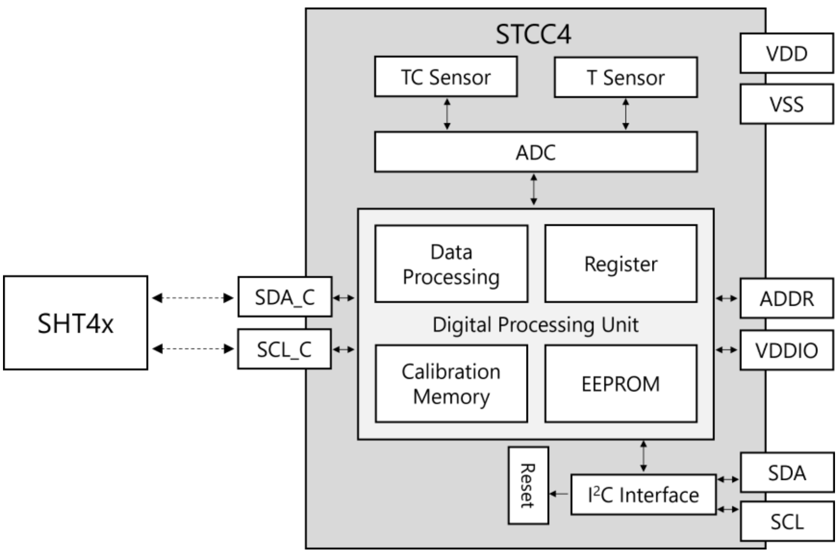


Highlights

- Thermal conductivity measurement principle
- CO_2 measurement accuracy ±(100 ppm + 10%) from 400 – 5’000 ppm
- Digial I²C interface and calibrated output signal
- Avg. current consumption below 100 µA in single shot measurement mode
- Configurable I²C address
- Tape and reel package, reflow solderable

The STCC4 is Sensirion’s next generation miniature CO_2 sensor for indoor air quality applications. Based on the thermal conductivity sensing principle and Sensirion’s CMOSens® technology, the STCC4 enables monitoring of CO_2 gas concentration in ambient indoor air conditions at an unmatched cost-effectiveness and form factor. SMD assembly as well as tape & reel packaging allows cost- and space-effective integration of the STCC4 for high-volume applications. The STCC4 is 100% factory-calibrated and enables automatic on-board compensation of the CO_2 output for humidity and temperature through an external SHT4x sensor.

Functional Block Diagram



Contents

1 Measurement Specifications

1.1 CO_2 Sensing Performance

The CO_2 sensing performance specifications in **Table 1** are valid for default conditions of 25 °C, 50 %RH, 1013 hPa, continuous measurement mode with 1 s sampling interval and 3.3 V supply voltage.

Parameter	Conditions	Min.	Typ.	Max.	Unit
CO_2 output range		380		32'000	ppm
CO_2 measurement accuracy[1], continuous measurement mode	400 – 5'000 ppm, SHT4x temperature and humidity compensation		± (100 ppm + 10% of reading)		ppm
CO_2 measurement accuracy[1], single shot measurement mode	400 – 5'000 ppm, SHT4x temperature and humidity compensation, 10 s sampling interval		± (100 ppm + 10% of reading)		ppm
Digital resolution			1		ppm
Response time[2]	$\tau_{63\%}$, step change 2'000 – 400 ppm		20		s

Table 1. CO_2 sensing performance

1.1.1 Thermal Conductivity Measurement Principle

The sensor measures the thermal conductivity of the gas surrounding the sensing element. Any variation in the gas composition results in the thermal conductivity deviating from fresh air (defined as a composition of 78% N_2, 21% O_2, 0.93% Ar, 400 ppm CO_2 and a variable content of H_2O depending on the relative humidity) and is interpreted as a change in CO_2 concentration. Compositions of artificial reference gas mixtures, such as 100% N_2 or 80% N_2/20% O_2, deviate substantially from fresh air and can lead to measurement errors.

1.1.2 Automatic Self-Calibration

The sensor is operated with a built-in automatic self-calibration (ASC) algorithm to maintain long-term stability of the CO_2 sensing performance. The algorithm assumes that the sensor during operation is exposed to fresh air containing approximately 400 ppm CO_2 concentration at least once per week. Exposure to CO_2 concentrations lower than 400 ppm can affect the sensor accuracy. The ASC state is stored in non-volatile memory at a maximum interval of 2 hours in continuous measurement mode or after 720 single shot measurements, corresponding to 2 hours in single shot measurement mode with a 10 s sampling interval.

1.1.3 Warm-Up

After idle or power-off periods longer than 3 hours, the CO_2 measurement accuracy is achieved after a maximum of 1 hour of operation in continuous measurement mode or 360 single shot measurements, corresponding to 1 hour in single shot measurement mode with a 10 s sampling interval. The *perform_conditioning* command (**Section 3.4.9)** is recommended to improve the CO_2 sensing performance after long idle or power-off periods.

1.1.4 Initial Operation

Initial operation occurs after the first sensor power-up. CO_2 measurement accuracy is achieved after a maximum of 12 hours of operation in continuous measurement mode[3], followed by exposure to fresh air containing approximately 400 ppm CO_2 concentration. The first ASC state is saved after sensor operation for 1 hour in continuous measurement mode or 360 single shot measurements. The sensor will complete a bypass phase with a CO_2 concentration output of 390 ppm during the first 20 s of continuous measurement mode or the first 2 single shot measurements. Restarting the continuous measurement mode or power-cycling within the first hour of sensor operation will reinitialize the bypass phase and timer for the first ASC state save. The *perform_factory_reset* command (**Section 3.4.11)** reinitializes the bypass phase and resets the ASC history.

[1] Deviation from a high-precision reference with gas mixtures having a ±2% tolerance.
[2] Response time depends on design-in, signal update rate and environment of the sensor in the final application.
[3] Initial operation duration increases for sampling intervals greater than 1 s.

2 Sensor Specifications

2.1 Recommended Environmental Conditions

The sensor is optimized for operation and storage within the environmental conditions listed in **Table 2**. For an extended operating range, external pressure input through the *set_pressure_compensation* command (**Section 3.4.5**) can improve CO_2 sensing performance.

Parameter	Conditions	Min.	Typ.	Max.	Unit
Operating temperature		10	25	40	°C
Storage temperature		10	25	50	°C
Relative humidity	Non-condensing, max dew point 35 °C	20	50	80	%RH
Pressure	Without pressure compensation	85'000	101'300	110'000	Pa
	With pressure compensation	70'000	101'300	110'000	Pa

Table 2. Recommended environmental conditions

2.2 Electrical Specifications

Default conditions of 25 °C and 3.3 V supply voltage apply to the values in **Table 3**, unless otherwise stated.

Parameter	Sym.	Conditions	Min	Typ	Max	Unit
Supply voltage	V_{DD}		2.7	3.3	5.5	V
Unloaded supply voltage ripple	V_{RPP}	Without the load of the sensor			30	mV
Peak supply current[4]	I_{peak}			3.7	4.2	mA
Average supply current	$\langle I_{DD} \rangle$	Continuous measurement mode		950		µA
		Single shot measurement mode[5], 10 s sampling interal		100		µA
		Idle mode		55		µA
		Sleep mode			1	µA
I²C communication voltage	V_{I2C}		1.8		V_{DD}	V
Low level input voltage	V_{IL}		0		$0.3 \cdot V_{I2C}$	V
High level input voltage	V_{IH}		$0.7 \cdot V_{I2C}$		V_{I2C}	V
Low level output voltage	V_{OL}	$R_p \geq 1.5$ kΩ, max sink current 3 mA	0		$0.2 \cdot V_{I2C}$	V
Capacitive bus load[6]	C_b	$R_p \geq 1.5$ kΩ, max sink current 3 mA, Fast mode Plus		-	90	pF

Table 3. Electrical specifications

[4] Higher transient currents on shorter timescales than 10 microseconds may be observed but are typically negligible due to parasitic R/L/C elements in design-in.
[5] On-demand measurement with adjustable sampling interval. See Section 3.4.6 for more information.
[6] Refer to the I²C-bus specification for proper dimensioning to achieve desired communication frequency. NXP I2C-bus specification and user manual UM10204, Rev.7, 01 November 2021.

2.3 Absolute Maximum Ratings

Stress levels beyond those listed in **Table 4** may cause permanent damage to the sensor. Exposure to minimum/maximum rating conditions for extended time periods may affect sensor performance and reliability.

Parameter	Conditions	Min	Max	Unit
MSL level			1	
Supply voltage		-0.3	5.8	V
Voltage on all pins		-0.3	V_{DD}+0.3	V
Operating temperature		-40	85	°C
Short-term storage temperature[7]		-40	85	°C
Operating relative humidity	Non-condensing	0	95	%RH
ESD HDM	JEDEC JS-001		2	kV
ESD CDM	JEDEC JS-002		500	V
Latch-up	JESD78 Class II, 125 °C	-100	100	mA
Sensor lifetime	Default operating conditions (**Section 1.1**)	10		years

Table 4. Absolute maximum ratings

2.4 Hardware Interface Specifications

The STCC4 comes in a metal cap LGA package with a pin assignment as described in **Table 5**.

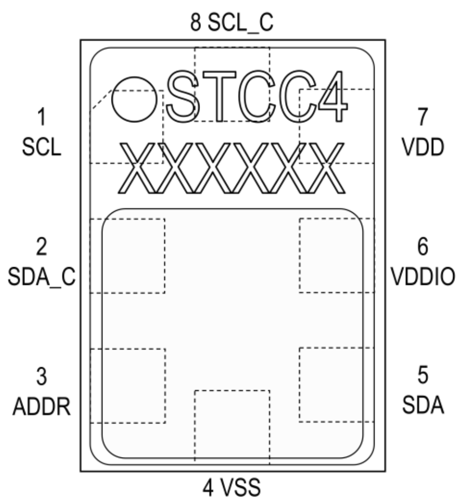
Pin	Symbol	Description	Pin assignment
1	SCL	I^2C serial clock input	
2	SDA_C	I^2C serial data input/output to/from SHT4x[8]	
3	ADDR	I^2C address configuration ADDR = GND → 0x64 ADDR = VDD → 0x65	
4	VSS	Ground	
5	SDA	I^2C serial data input/output	
6	VDDIO	I^2C communication voltage configuration[9,10]	
7	VDD	Supply voltage	
8	SCL_C	Serial clock output to SHT4x[8]	

Table 5. Pin assignment (transparent top view). Dashed lines are only visible from the bottom of the sensor.

[7] Short term storage refers to temporary conditions, *e.g.*, during transport.
[8] The SDA_C/SCL_C pins must be soldered to a floating pad if not connected to the SHT4x.
[9] The required I^2C communication voltage must be applied to the VDDIO pin during sensor power-up.
[10] The I^2C communication voltage is set to V_{DD} when the voltage applied on the VDDIO pin is less than 0.7 V.

2.5 Temperature and Humidity Compensation

The STCC4 requires continuous input from an external SHT4x temperature and humidity sensor for accurate compensation of the CO_2 concentration output. The recommended application circuit for the STCC4 is shown in **Figure 1**. The STCC4 has a dedicated I^2C controller interface for connecting to SHT4x sensors with I^2C address 0x44. The STCC4 I^2C controller interface pads SDA_C and SCL_C have internal pull-up resistors of 10 kΩ. Additional pull-up resistors between the STCC4 and SHT4x are not recommended if the SHT4x is designed close to the STCC4. The pull-up resistor values (R_p) must be dimensioned based on the bus capacity, communication frequency and NXP I^2C-bus specification and user manual[11].

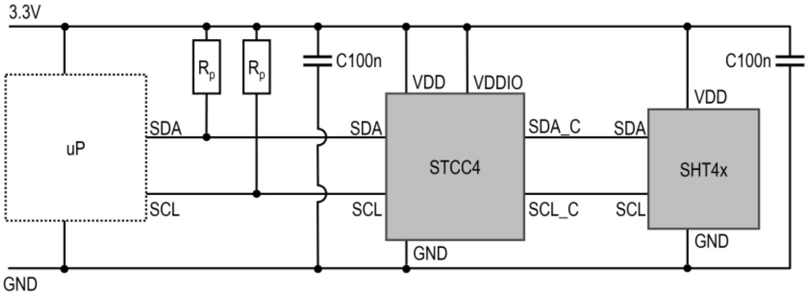


Figure 1. Recommended application circuit. The positioning of the pins is only for illustrative purposes.

2.6 Timing Specifications

Parameter	Sym.	Conditions	Min	Typ	Max	Unit
Power-up time	t_{PU}	After hard reset, $V_{DD} \geq 2.7$ V		10		ms
I^2C SCL frequency	f_{I2C}			400	1'000	kHz

Table 6. Timing specifications

2.7 Mechanical Specifications

Parameter	Sym.	Conditions	Min	Typ	Max	Unit
Mass	m			0.02		g

Table 7. Mechanical specifications

2.8 Material Specifications

Parameter	Conditions
REACH, RoHS, Halogen-Free	Compliant

Table 8. Material specifications

[11] NXP I^2C-bus specification and user manual UM10204, Rev.7, 01 November 2021

3 Sensor Operation

The STCC4 uses I²C communication based on the NXP I2C-bus specification and user manual[12]. Supported I²C modes are Standard-mode, Fast-mode and Fast-mode Plus. Clock stretching is not supported.

3.1 I²C Address

The I²C address (I2C ADDR) for the STCC4 is 0x64. See **Section 2.4** to select the alternative I²C address 0x65.

3.2 I²C Data Transfer Formats

The write, read and combined data transfer formats are visualized in **Figure 2**. Data and commands are transferred in multiples of 16-bit words, with the most significant byte (MSB) transmitted first. All transfers must begin with a start condition (S) and terminate with a stop condition (P). A sensor is addressed by sending its 7-bit I²C address, followed by an eighth data direction bit denoting the communication direction (W/R): "zero" indicates transmission to the target (i.e., "WRITE") and "one" indicates a request for data (i.e., "READ"). Data words are succeeded by an 8-bit checksum (cyclic redundancy check CRC-8, see **Section 3.3**). Command words (CMD) contain a 3-bit CRC. In the write direction, the checksum must be transmitted. In read direction, the master may abort transmission after any data byte by sending a not acknowledge (NACK) and a stop condition. After receiving a command, the sensor requires the specified execution time before responding with a ACK.

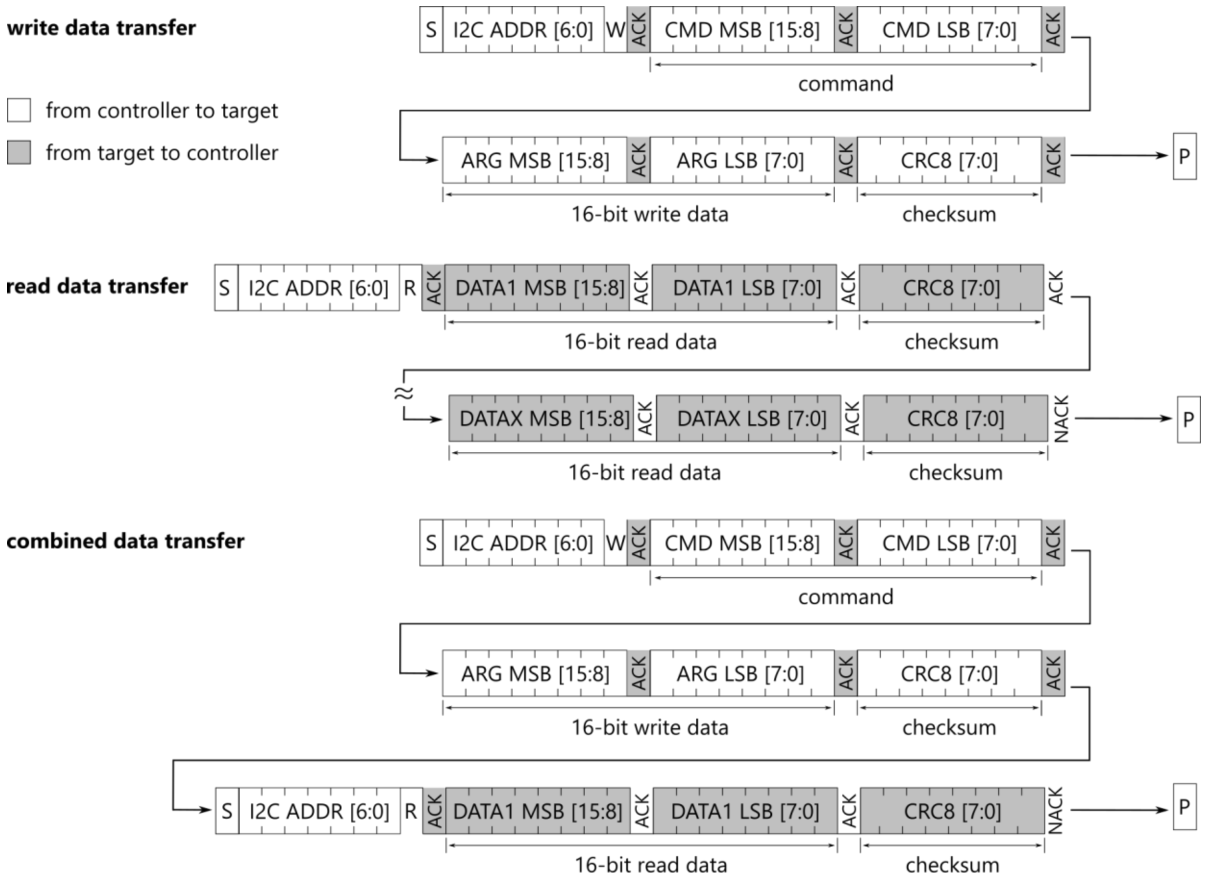


Figure 2. Write, read and combined data transfer formats

[12] NXP I²C-bus specification and user manual UM10204, Rev.7, 01 November 2021

3.3 Checksum Calculation

The 8-bit checksum is calculated from the two previously transmitted data bytes with the algorithm in **Table 9**.

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/output	False/False
Final XOR	0x00
Example	CRC (0xBEEF) = 0x92

Table 9. Data checksum properties

3.4 I²C Commands

Section	Command	Hex Code	Executable during Measurement
3.4.1	*start_continuous_measurement*	0x218B	No
3.4.2	*stop_continuous_measurement*	0x3F86	Yes
3.4.3	*read_measurement*	0xEC05	Yes
3.4.4	*set_rht_compensation*	0xE000	Yes
3.4.5	*set_pressure_compensation*	0xE016	Yes
3.4.6	*measure_single_shot*	0x219D	No
3.4.7	*enter_sleep_mode*	0x3650	No
3.4.8	*exit_sleep_mode*	0x00	No
3.4.9	*perform_conditioning*	0x29BC	No
3.4.10	*perform_soft_reset*	0x06	Yes
3.4.11	*perform_factory_reset*	0x3632	No
3.4.12	*perform_self_test*	0x278C	No
3.4.13	*enable_testing_mode*	0x3FBC	Yes
3.4.14	*disable_testing_mode*	0x3F3D	Yes
3.4.15	*perform_forced_recalibration*	0x362F	No
3.4.16	*get_product_ID*	0x365B	No

Table 10. List of I²C commands

3.4.1 start_continuous_measurement

The *start_continuous_measurement* command will start a continuous measurement.

Command	Command Hex Code	Argument	Read Data	Execution Time (ms)	Description
start_continuous_measurement	0x218B	-	-	-	Starts continuous measurement with 1 s sampling interval.

Recommended operation sequence:

1. Send the *start_continuous_measurement* command.
2. Wait 1 s[13].
3. Send the *read_measurement* command (**Section 3.4.3**) and wait the specified execution time.
4. Read out the measurement data.
   4.1. If data is not yet available, wait 150 ms and retry to read out the measurement data.
5. Wait 1 s[13].
6. Repeat steps 3-5 as needed.
7. To stop the continuous measurement, send the *stop_continuous_measurement* command (**Section 3.4.2**) and wait the specified execution time.

3.4.2 stop_continuous_measurement

The *stop_continuous_measurement* command will finish the currently running measurement before returning to idle mode. During the execution time, the sensor will not acknowledge its I^2C address nor accept commands.

Command	Command Hex Code	Argument	Read Data	Execution Time (ms)	Description
stop_continuous_measurement	0x3F86	-	-	1'200	Stops the continuous measurement and put the sensor into idle mode.

3.4.3 Read_measurement

Measurement data is read out through the *read_measurement* command. The measurement data buffer is emptied upon read-out. Subsequent measurement data can be readout by sending the sensor's I^2C address and the read direction bit. The sensor will respond with a NACK if no measurement data is available. The I^2C master can abort the read transfer with a NACK followed by a STOP condition after any data byte. See **Section 3.5** for the signal output and input conversion. The sensor status is used to determine if the sensor is in testing mode (See **Section 3.4.13**).

Command	Command Hex Code	Argument	Read Data	Execution Time (ms)	Description
read_measurement	0xEC05	-	Byte0: CO_2 concentration 8msb Byte1: CO_2 concentration 8lsb Byte2: CRC Byte3: Temperature 8msb Byte4: Temperature 8lsb Byte5: CRC Byte6: Relative Humidity 8msb Byte7: Relative Humidity 8lsb Byte8: CRC Byte9: Sensor Status 8msb Byte10: Sensor Status 8lsb Byte11: CRC	1	Reads out the measurement data. Values for temperature and humidity are provided as received from the external temperature and humidity sensor.

[13] Note that the sensor and the microcontroller are subject to clock tolerances. The effective sampling interval is 1'000 ms ± 150 ms.

3.4.4 set_rht_compensation

External relative humidity (RH) and temperature (T) compensation values can be written through the *set_rht_compensation* command when the SHT4x is not controlled by STCC4 through the dedicated I²C controller interface (see **Section 2.5**). The RH and T values must be provided from the same RHT sensor. The written RHT values are utilized for RHT compensation after a maximum of one measurement interval. The default or last written values are used for RHT compensation until overwritten. Power cycling resets the values to the default values of 25 °C and 50 %RH. See **Section 3.5** for the signal output and input conversion. Do not use the *set_rht_compensation* command when an SHT4x is controlled by STCC4 through the I²C controller interface.

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
set_rht_compensation	0xE000	Byte0: Temperature 8msb Byte1: Temperature 8lsb Byte2: CRC Byte3: Relative humidity 8msb Byte4: Relative humidity 8lsb Byte5: CRC	-	1	Writes the RHT values for compensation. Example for 25 °C and 50 %RH: [0xE0, 0x00, 0x66, 0x66, 0x93, 0x72 0xB0, 0xDC]

3.4.5 set_pressure_compensation

External pressure values can be written through the *set_pressure_compensation* command. The written pressure value is applied for pressure compensation after a maximum of one measurement interval. The default or the last written value is used in pressure compensation until overwritten. Power cycling resets the sensor to the default value of 101’300 Pa. See **Section 3.5** for the signal output and input conversion. Input values are clipped to a range between 40’000 – 110’000 Pa.

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
set_pressure_compensatoin	0xE016	Byte0: Pressure 8msb Byte1: Pressure 8lsb Byte2: CRC	-	1	Writes the pressure value. Example for 101’300 Pa: [0xE0, 0x16, 0xC5, 0xDA, 0x83]

3.4.6 measure_single_shot

The *measure_single_shot* command conducts an on-demand measurement of CO_2 gas concentration.

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
measure_single_shot	0x219D	-	-	500	Performs a single shot measurement.

Recommended operation sequence:

1. Wake the sensor up from sleep mode to idle mode with the *exit_sleep_mode* command (**Section 3.4.8**).
2. Send the *measure_single_shot* command and wait for the specified execution time.
3. Send the *read_measurement* command (**Section 3.4.3**) and wait for the specified execution time.
4. Read out the measurement data.
5. Set the sensor to sleep mode with *the enter_sleep_mode* command (**Section 3.4.7**).
6. Wait before the next measurement. A sampling interval between 5 s and 600 s (10 minutes) is recommended to ensure proper operation of the ASC algorithm.
7. Repeat steps 1-5 as required by the application.

3.4.7 enter_sleep_mode

The *enter_sleep_mode* command sets the sensor from idle to sleep mode through the I²C interface. The written relative humidity, temperature, pressure compensation values and ASC state are retained while in sleep mode.

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
enter_sleep_mode	0x3650	-	-	1	Sets the sensor from idle mode into sleep mode.

3.4.8 exit_sleep_mode

The *exit_sleep_mode* command wakes the sensor up from sleep mode to idle mode upon receiving its I²C address, a write data direction bit and a payload byte 0x00. Note that the payload byte is not acknowledged. The wake up of the sensor into idle mode can be confirmed by reading out the product ID (see **Section 3.4.16**).

Command	Payload Byte	Argument	Consecutive Read	Execution Time (ms)	Description
exit_sleep_mode	0x00	-	-	5	Wakes the sensor from sleep into idle mode.

3.4.9 perform_conditioning

The *perform_conditioning* command is recommended to improve the initial CO_2 sensing performance when the sensor has not completed measurements for more than 3 hours (See **Section 1.1.3**).

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
perform_conditioning	0x29BC	-	-	22'000	Conditions the sensor with a set operation profile.

Recommended operation sequence:

1. Power up the sensor or wake the sensor up with the *exit_sleep_mode* command (**Section 3.4.8**).
2. Send the *perform_conditioning* command and wait for the specified execution time.
3. Send a measurement command; *e.g.,* the *start_continuous_measurement* command (**Section 3.4.1**) or the *measure_single_shot* command (**Section 3.4.6**).

3.4.10 perform_soft_reset

The *perform_soft_reset* command triggers a soft reset of the sensor through the I²C general call reset as implemented according to the NXP I²C-bus specification and user manual[14]. The *perform_soft_reset* command is not acknowledged by the sensor. During the execution time, the sensor will not acknowledge its I²C address nor accept commands. The general call I²C address is 0x00, the command is 8 bits long and all devices on the same I²C bus designed to respond to a general call I²C reset will also complete a soft reset.

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
perform_soft_reset	0x06	-	-	10	Resets the sensor to the same state as after a power cycle.

[14] NXP I2C-bus specification and user manual UM10204, Rev.7, 01 November 2021

3.4.11 perform_factory_reset

The *perform_factory_reset* command resets the FRC and ASC algorithm history, as well as reenables the bypass phase (See **Section 1.1.4** for more information).

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
perform_factory_reset	0x3632	-	Word[0] = 0 → pass Word[0] = 0xFFFF → command failed	90	Resets the FRC and ASC algorithm history.

3.4.12 perform_self_test

The *perform_self_test* command can be used to check the sensor functionality in an end-of-line test as well as for design-in and debugging purposes. The self-test should be performed during stable conditions, *i.e.,* stable supply voltage, environmental conditions and CO_2 concentration.

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
perform_self_test	0x278C	-	Byte0: Self-test 8msb Byte1: Self-test 8lsb Byte2: CRC	360	Performs an on-chip self-test. A successful test will return either 0x0000 or 0x0010.

The self-test output is decoded as follows:

Bits	Nonzero Value
0	Supply voltage is out of specified range
3:1	For debugging purposes; contact Sensirion for support
4	SHT is not connected through STCC4 I^2C controller interface pad
6:5	Memory error

In case of a memory error, the recommended operation sequence is:

1. Send the *perform_soft_reset* command (See **Section 3.4.10**) and wait for the specified execution time. Then resend the *perform_self_test* command and wait for the specified execution time.
2. If the memory error persists, power cycle the supply voltage, then resend the *perform_self_test* command and wait for the specified execution time.
3. If the memory error persists, measurement results may be compromised.

3.4.13 enable_testing_mode

The *enable_testing_mode* command is used to pause the ASC algorithm and temporarily disable updates to the ASC state. It may be used for testing, *e.g.*, the CO_2 sensing performance during sensor qualification. The sensor is in testing mode when the 2^{nd} most significant bit of Byte 10 in the *read_measurement* command (**Section 3.4.3**) output is equal to 1.

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
enable_testing_mode	0x3FBC	-	-	-	Enables the testing mode.

3.4.14 disable_testing_mode

The *disable_testing_mode* command is used to exit the testing mode. The sensor is not in testing mode when the 2nd most significant bit of Byte 10 from the *read_measurement* (**Section 3.4.3**) output is equal to 0.

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
disable_testing_mode	0x3F3D	-	-	-	Disables the testing mode.

3.4.15 perform_forced_recalibration

The *perform_forced_recalibration* command (FRC) is used to correct the sensor's CO_2 concentration output with an externally provided target CO_2 concentration. Ensure the sensor reading and environmental conditions, including CO_2 concentration, are stable for the duration of the recommended operation sequence. See **Section 3.5** for the signal output and input conversion. Accepted input values are between 0 – 32'000 ppm.

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
perform_forced_recalibration	0x362F	Byte0: Target CO_2 concentration 8msb Byte1: Target CO_2 concentration 8lsb Byte2: CRC	Byte0: CO_2 concentration correction 8msb Byte1: CO_2 concentration correction 8lsb Byte2: CRC	90	Performs FRC to the target CO_2 concentration. Failed command execution will return 0xFFFF.

Recommended operation sequence:

1. Operate the sensor for a minimum of 30 s in continuous mode or 30 single shot measurements, corresponding to 5 minutes in single shot measurement mode with a 10 s sampling interval. For sampling intervals higher than 10 s, increase the operation time accordingly.
2. If operating in continuous mode, send the *stop_continuous_measurement* command (**Section 3.4.2**) and wait for the specified execution time. Else if operating in single shot mode, the sensor must remain in idle mode, *i.e.*, must not be sent to sleep mode, after operation.
3. Send the *perform_forced_recalibration* command with the target CO_2 concentration and optionally read out the applied FRC correction.

3.4.16 get_product_id

The *get_product_ID* command can be used to identify the sensor and verify the communication.

Command	Command Hex Code	Argument	Consecutive Read	Execution Time (ms)	Description
Get_product_id	0x365B	-	6 x (2 Bytes + 1 CRC)	1	Returns a 32-bit product ID and 64-bit unique serial number.

Product	Product ID
STCC4	0x0901018A

3.5 Conversion of Signal Input and Output

The conversion formulas for I²C command inputs and digitally calibrated outputs can be found in **Table 11**.

Signal	Sym.	Type	Int.	Conversion Formula	Example
CO_2 gas concentration	C	Output	i16	$C = \text{Output}$	$500\ ppm = 500$
Relative humidity	RH	Input	u16	$Input = \frac{(RH\ [\%RH] + 6)(2^{16} - 1)}{125}$	$29360 = \frac{(50\ \%RH + 6)(2^{16} - 1)}{125}$
		Output	u16	$RH = 125 \cdot \frac{Output}{2^{16} - 1} - 6$	$50\ \%RH = 125 \cdot \frac{29'360}{2^{16} - 1} - 6$
Temperature	T	Input	u16	$Input = \frac{(T\ [°C] + 45)(2^{16} - 1)}{175}$	$26214 = \frac{(25\ °C + 45)(2^{16} - 1)}{175}$
		Output	u16	$T = 175 \cdot \frac{Output}{2^{16} - 1} - 45$	$25\ °C = 175 \cdot \frac{26'214}{2^{16} - 1} - 45$
Pressure	P	Input	u16	$Input = \frac{P\ [Pa]}{2}$	$50560 = \frac{101'300\ Pa}{2}$
FRC CO_2 Concentration Correction	C_{FRC}	Input	u16	$Input = C_{Target}$	$500 = 500\ ppm$
		Output	u16	$C_{FRC} = Output - 32'768$	$-100\ ppm = 32'668 - 32'768$

Table 11. Signal input and output conversion formulas

4 Physical Specification

4.1 Package Description

STCC4 consists of a metal cap LGA package. The sensor opening is protected by a membrane on the metal cap. The protective membrane must not be removed or tampered with. Sensors must be treated according to Moisture Sensitivity Level 1 (MSL1) as per IPC/JEDEC J-STD-033D[15]. It is recommended to process the sensors within one year after delivery date.

4.2 Package Outline

The STCC4 package outline with nominal dimensions and tolerances can be seen in **Figure 3**.

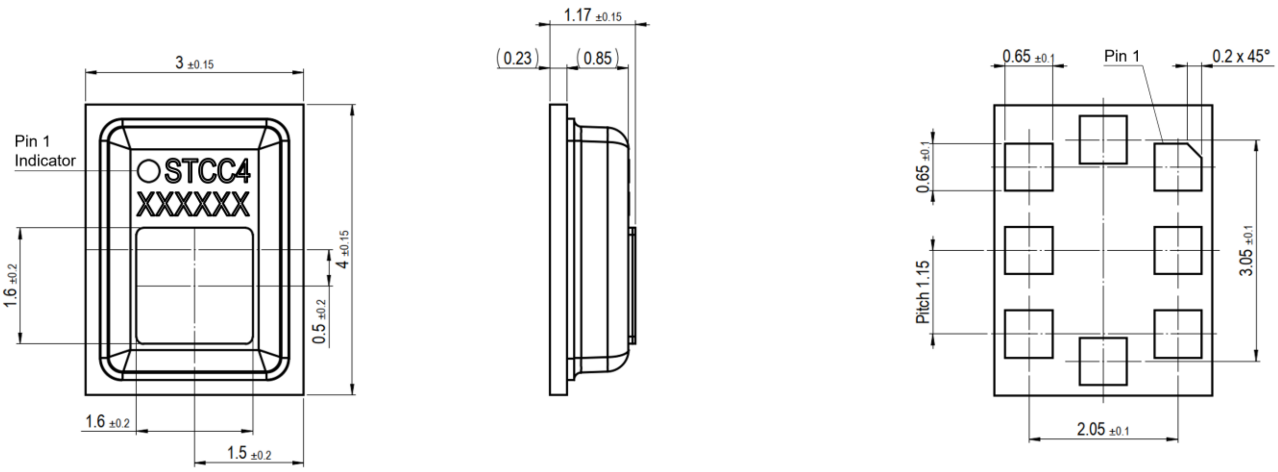


Figure 3. Package outline drawing. All dimensions in millimeters.

4.3 Land Pattern

The recommended land pattern for STCC4 can be seen in **Figure 4**. Pin 1 is denoted by a chamfered edge. Pads on PCB are recommended to be non-solder mask defined (NSMD). The exact mask geometries, distances and stencil thicknesses must be adapted to the required soldering processes.

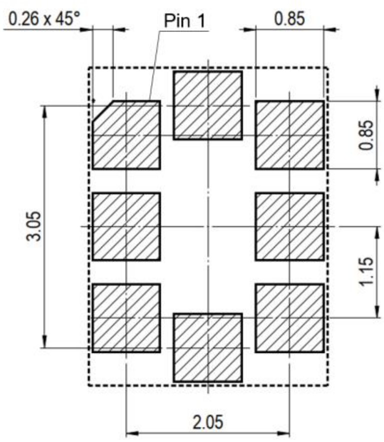


Figure 4. Recommended land pattern. All dimensions in millimeters.

[15] IPC/JEDEC J-STD-033D, April 2018

4.4 Traceability and Identification

All STCC4 sensors include a laser marking for identification and traceability as shown in **Figure 5**. The first line of the laser marking includes a filled circle as a pin-1 indicator, followed by the product name (i.e. STCC4). The second line of the laser marking serves as an internal batch tracking code.

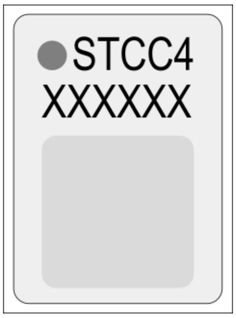


Figure 5. Laser marking illustration

4.5 Soldering Instructions

The STCC4 sensors are designed to withstand a soldering profile for Pb-free assembly based on IPC/JEDEC J-STD-020[16] in IR/Convection reflow ovens, as seen in **Figure 6**. Recommended conditions are peak temperature T_P = 260 °C, time within actual peak temperature t_p = 30 s and a maximum ramp-down rate of < 4 °C/s. The sensor is not compatible with vapor phase reflow soldering. The membrane on top of the cap must not be removed or wetted with any liquid. Do not apply any board wash process step subsequently to the reflow soldering. If the PCB hosting the sensor passes through multiple solder cycles, it is recommended to assemble the sensor during the last solder cycle.

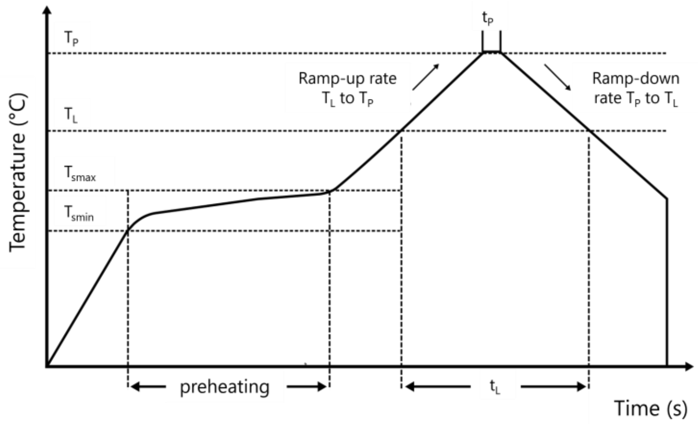


Figure 6. Recommended soldering profile based on IPC/JEDEC J-STD-020.

[16] IPC/JEDEC J-STD-020E, December 2014

5 Tape and Reel Packaging

The specifications for the tape and reel packaging can be found in **Figure 7**. The tape and reel packaging is based on DIN EN 60286-3[17]. The reel diameter is 7 inches for the 1'500-piece packaging size.

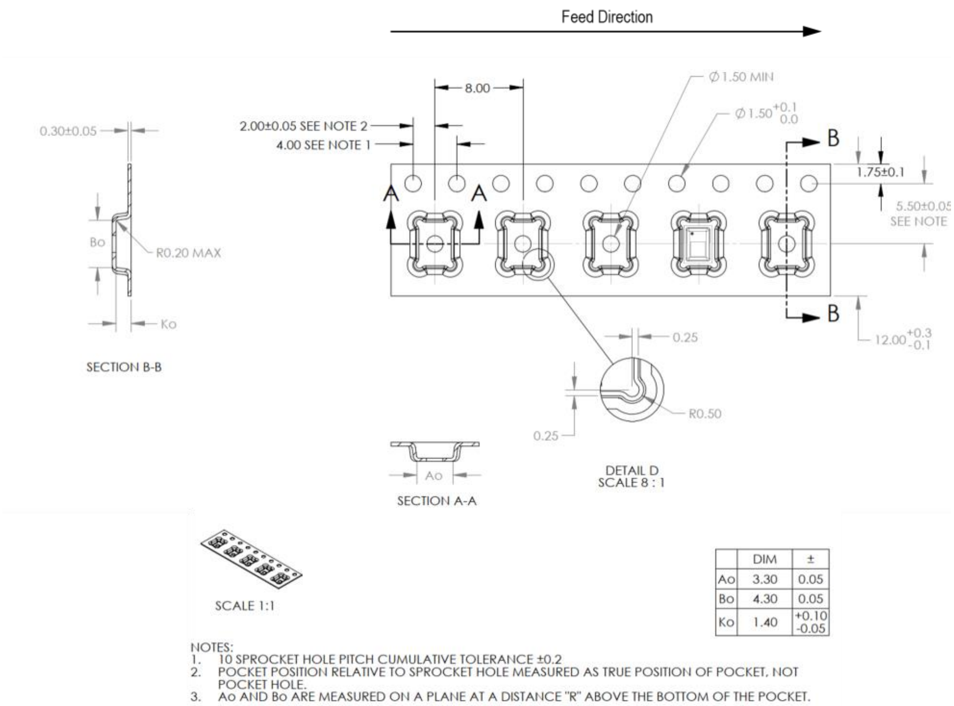


Figure 7. Technical drawing of tape and reel packaging. All dimensions in millimeters.

6 Ordering Information

Material Description	Material Number	Details	Quantity (pcs)
STCC4-D-R3	3.000.976	STCC4-D-R3 CO2 I2C, ToR 1500 pcs	1'500
SEK-STCC4-Sensor	3.001.009	SEK-STCC4-Sensor Evaluation Kit, STCC4 on dev. board w. cables	1

Table 12. Ordering information

7 Revision History

Date	Version	Pages	Changes
June 2025	1	all	Initial version

[17] DIN EN 60286-3:2007, April 2008

SENSIRION

Important Notices

Warning, Personal Injury

Do not use this product as safety or emergency stop devices or in any other application where failure of the product could result in personal injury. Do not use this product for applications other than its intended and authorized use. Before installing, handling, using or servicing this product, please consult the data sheet and application notes. Failure to comply with these instructions could result in death or serious injury.

If the Buyer shall purchase or use SENSIRION products for any unintended or unauthorized application, Buyer shall defend, indemnify and hold harmless SENSIRION and its officers, employees, subsidiaries, affiliates and distributors against all claims, costs, damages and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if SENSIRION shall be allegedly negligent with respect to the design or the manufacture of the product.

ESD Precautions

The inherent design of this component causes it to be sensitive to electrostatic discharge (ESD). To prevent ESD-induced damage and/or degradation, take customary and statutory ESD precautions when handling this product. See application note "ESD, Latchup and EMC" for more information.

Warranty

SENSIRION warrants solely to the original purchaser of this product for a period of 12 months (one year) from the date of delivery that this product shall be of the quality, material and workmanship defined in SENSIRION's published specifications of the product. Within such period, if proven to be defective, SENSIRION shall repair and/or replace this product, in SENSIRION's discretion, free of charge to the Buyer, provided that:

- notice in writing describing the defects shall be given to SENSIRION within fourteen (14) days after their appearance;
- such defects shall be found, to SENSIRION's reasonable satisfaction, to have arisen from SENSIRION's faulty design, material, or workmanship;
- the defective product shall be returned to SENSIRION's factory at the Buyer's expense; and
- the warranty period for any repaired or replaced product shall be limited to the unexpired portion of the original period.

This warranty does not apply to any equipment which has not been installed and used within the specifications recommended by SENSIRION for the intended and proper use of the equipment. EXCEPT FOR THE WARRANTIES EXPRESSLY SET FORTH HEREIN, SENSIRION MAKES NO WARRANTIES, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THE PRODUCT. ANY AND ALL WARRANTIES, INCLUDING WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY EXCLUDED AND DECLINED.

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SENSIRION does not assume any liability arising out of any application or use of any product or circuit and specifically disclaims any and all liability, including without limitation consequential or incidental damages. All operating parameters, including without limitation recommended parameters, must be validated for each customer's applications by customer's technical experts. Recommended parameters can and do vary in different applications.

SENSIRION reserves the right, without further notice, (i) to change the product specifications and/or the information in this document and (ii) to improve reliability, functions and design of this product.

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