SENSIRION

Testing Guidelines

For STCC4 CO_2 Sensors

Sensirion's STCC4 carbon dioxide (CO_2) sensors are designed to deliver optimized CO_2 accuracy in indoor air quality applications. Several test methods are recommended across common testing stages to evaluate sensor performance during integration. Please read these testing guidelines in combination with the STCC4 datasheet, handling instructions, and design-in guidelines during the sensor integration.

Key Instructions

- Complete the initial operation and warm-up before assessing sensor performance
- Test using sensor configuration and compensation settings for the final application
- Follow the handling and design-in guidelines to avoid external impact on sensor output
- Test defined CO_2 concentrations balanced with a fresh air composition
- Evaluate in stable environmental conditions
- Minimize test chamber volume and ensure a uniform gas composition

Common testing stages during sensor integration include:

Sensor evaluation	Design-in testing	Sensor qualification	End-of-line and sample testing	Final application operation
				

The testing method section titles below indicate which methods are recommended for each testing stage.

Contents

1 General Recommendations

- Collect time traces of CO_2 concentration, temperature, and relative humidity (RH) throughout the tests.
- Collect time traces of pressure throughout tests with significant pressure variations.
- Include at least 3 STCC4 CO_2 sensors and at least 1 reference sensor for sufficient comparison data.
- Apply pressure compensation (see Section 3.4.5 of the STCC4 datasheet) when testing at pressures significantly different from the default condition of 101'300 Pa.
- Account for reference sensor and gas source uncertainty when assessing STCC4 CO_2 sensor specifications.
- Trigger automatic self-calibration (ASC) by introducing fresh air into the test environment through ventilation (*e.g.*, opening a window) for 5 – 10 minutes. Relocating the sensor outdoors is not required.
- Avoid unintended ASC activation by maintaining CO_2 concentrations ≥ 400 ppm during testing.

2 Built-In Sensor Self-Test

The *perform_self_test* command (see Section 3.4.12 of the STCC4 datasheet) is recommended to evaluate the sensor functionality and debug issues during:

- Design-in evaluation
- Sensor qualification
- End-of-line inspection
- Final application operation

A successful self-test will return either 0x0000 or 0x0010. Other outputs may require further actions (see Section 3.4.12 of the STCC4 datasheet).

3 Application Evaluation

Evaluating the sensor performance for the intended use-case is recommended during:

- Sensor evaluation: Assess the sensor performance in the final use-case environment
- Design-in evaluation: Assess the design-in on system-level sensor performance

3.1 Test Procedure

1. Complete the initial operation and warm-up as specified in Section 1 of the STCC4 datasheet.
2. Align the output of all sensors under testing to the test environment CO_2 concentration via the ASC or forced recalibration (FRC) command. Refer to the respective datasheet of each CO_2 sensor under test to achieve the specified accuracy via ASC or FRC.
3. Operate the STCC4 CO_2 sensors and the reference sensor for an extended duration (*e.g.*, weeks).
4. Evaluate the time traces of all sensors. **Figure 1** shows an example evaluation.

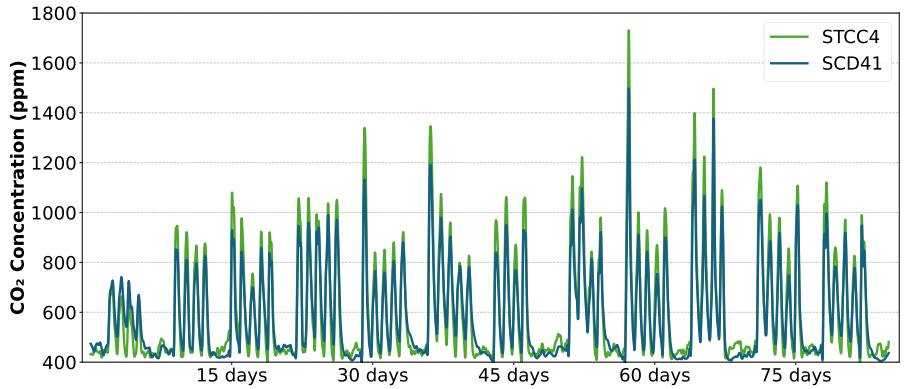

Figure 1: Example evaluation from time traces of STCC4 and SCD41 over 90 days in an office.

4 Sensor Specification Evaluation

Evaluating the STCC4 CO_2 sensor specifications is recommended during:

- Sensor evaluation
- Design-in
- Sensor qualification

The following guidelines enable confirmation of the sensor specifications. Deviation from these guidelines can increase measurement inaccuracy and affect the sensor output.

4.1 Measurement Setup

The measurement setup should include the following (see **Figure 2** for an example schematic):

- Air source
- Test chamber
- Reference CO_2 sensor
- Sensor operation and readout system

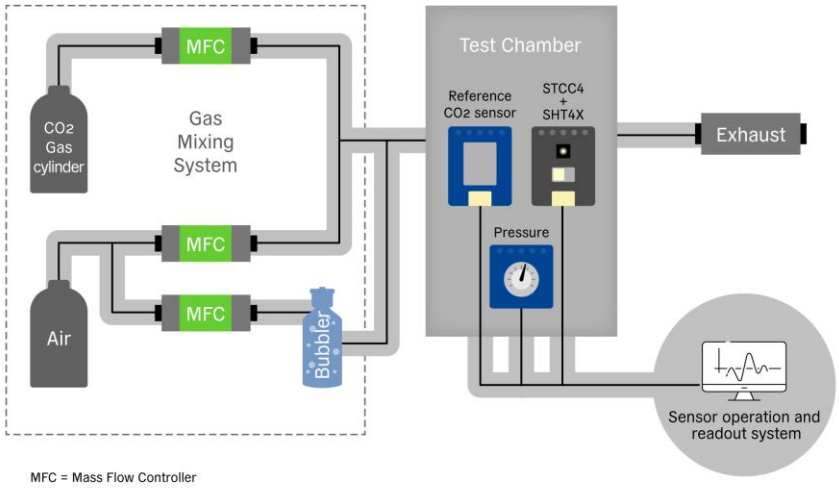

Figure 2: Example measurement setup schematic with a gas mixing system (GMS) as the air source. A fan can be used in the test chamber to promote a uniform gas distribution.

4.1.1 Air Source

The air source should provide defined CO_2 concentrations balanced in fresh air, defined as a composition of 78% nitrogen (N_2), 21% oxygen (O_2), 0.93% argon (Ar), 400 ppm CO_2 and a variable water (H_2O) content depending on relative humidity, and can be generated by either:

- Separate gas cylinders containing defined CO_2 concentrations balanced with fresh air
- Gas mixing system (GMS) consisting of multiple gas flow controllers (MFCs)

Significant deviations from the fresh air gas composition can lead to measurement errors. Synthetic air typically lacks Ar and humidity and must be conditioned to match the fresh air composition.

Air humidification should be implemented via a humidification unit (*e.g.*, bubbler). The humidification unit should be connected via a dedicated MFC between the air source and the test chamber to maintain constant humidity during CO_2 concentration changes. Condensation in the measurement setup should be avoided by operating above the dew point.

4.1.2 Test Chamber

A sealed test chamber should be used to maintain controlled environmental conditions and the test gas composition. The chamber should be designed to prevent the ingress of external air by using sealed electrical and pneumatic feedthroughs.

To manage the pressure in the test chamber, a one-way pressure relief valve should be used to allow controlled overpressure release. Gas flow rates should be selected to avoid turbulence or significant pressure variations within the test chamber. If a fan is used, ensure airflow remains low to avoid turbulence and avoid direct air flow onto the sensor. Connect the outlet of the test chamber to an exhaust or mass flow meter (MFM) specified for the test flow rate. Minimize the test chamber volume to reduce the impact on the measured response time.

Temperature and humidity should be controlled in the test chamber to the specified default conditions of 25 °C and 50 %RH (see Section 1.1 of the STCC4 datasheet). Monitor chamber pressure to ensure it does not deviate significantly from the default value of 101'300 Pa (see Section 1.1 of the STCC4 datasheet).

4.1.3 Reference CO_2 Sensor

A calibrated, high-accuracy reference CO_2 sensor should be used to validate the STCC4 CO_2 sensor accuracy. The reference sensor should meet the following criteria:

- CO_2 measurement accuracy better than or equal to ± 50 ppm ± 5% of reading
- Response time $\tau_{63\%} \leq 60$ s

The following reference sensors are recommended:

- Sensirion SCD43 CO_2 sensor
- Edinburgh Sensors Gascard NG
- LI-COR LI-850 CO_2 gas analyzer

4.2 CO_2 Accuracy Measurement Procedure

Evaluation of the STCC4 CO_2 sensor accuracy is recommended during sensor evaluation and qualification.

1. Complete the initial operation and warm-up as specified in Section 1 of the STCC4 datasheet.
2. Perform a FRC command on the STCC4 CO_2 sensors (see Section 3.4.15 of the STCC4 datasheet) and the reference CO_2 sensor to the test chamber CO_2 concentration.
3. Enable the testing mode on the STCC4 CO_2 sensors (see Section 3.4.13 of the STCC4 datasheet).
4. Apply a sequence of CO_2 concentration setpoints across the sensor's accuracy range. An example setpoint plot is shown in **Figure 3**. Sufficient dwell time is required at each CO_2 setpoint to ensure a stable CO_2 concentration within the test chamber. A dwell time of 30 min per setpoint is recommended.
5. Evaluate the sensors' output at the end of the dwell time at each CO_2 concentration setpoint.

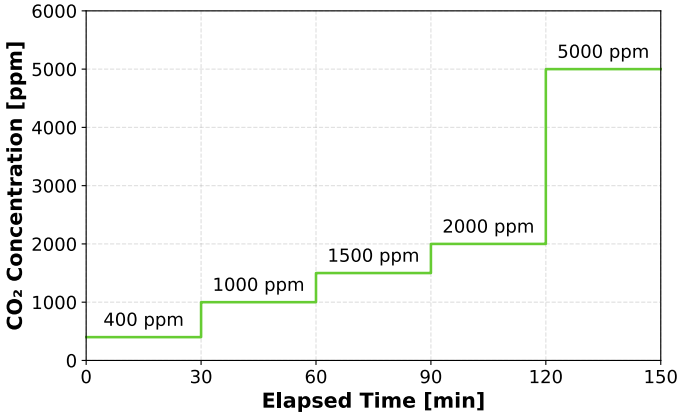

Figure 3: Example CO_2 concentration setpoint sequence.

4.3 Response Time Measurement Procedure

Evaluation of the STCC4 CO_2 sensor response time is recommended during:

- Design-in testing to minimize end-product influence on response time
- Bare-sensor qualification to verify sensor specification

The STCC4 CO_2 sensor response time specification applies only to continuous measurement mode. Minimize the impact of the measurement setup on the measured response time (*e.g.*, minimize test chamber volume, ensure a fast gas exchange rate).

1. Complete the initial operation and warm-up as specified in Section 1 of the STCC4 datasheet.
2. Perform a FRC command on the STCC4 CO_2 sensors (see Section 3.4.15 of the STCC4 datasheet) and the reference CO_2 sensor to the test chamber CO_2 concentration.
3. Enable the testing mode on the STCC4 CO_2 sensors (see Section 3.4.13 of the STCC4 datasheet).
4. Set the CO_2 concentration in the test chamber to 2'000 ppm and wait until the reference CO_2 sensor output has stabilized. The recommended dwell time is ≥ 5 min.
5. Introduce a step decrease in the CO_2 concentration by either:
   a. Setting the CO_2 concentration in the test chamber to 400 ppm.
   b. Removing the sensors from the test chamber into fresh air (*e.g.*, approximately 400 ppm).
6. Evaluate the sensor response time by calculating the time constant $\tau_{63\%}$ from 2'000 ppm to 400 ppm.

Figure 4 shows an illustrative example of a sensor response to a step-change in CO_2 concentration.

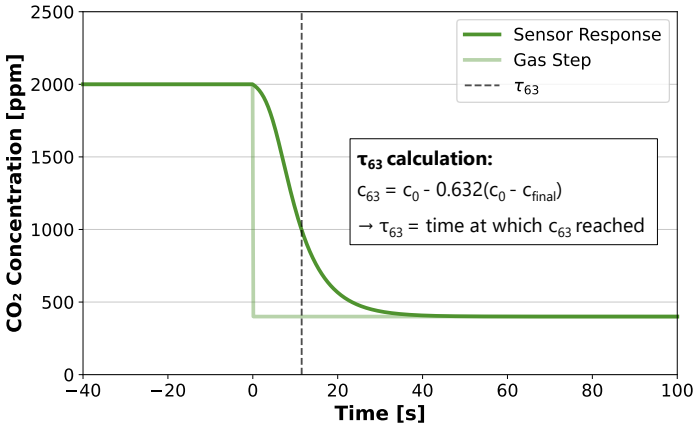

Figure 4: Example of a response time measurement.

5 End-of-Line and Sample Testing

A simplified sensor evaluation is recommended during:

- End-of-line (EOL) verification of sensor functionality
- Sample testing of production quality

Deviation from the **Section 4.1** evaluation guidelines result in reduced accuracy but remain sufficient for verification of sensor functionality and production quality.

The following guidelines apply to end-of-line and sample testing:

- Use test air with a gas composition close to fresh air. Air sources within a production facility can be sufficient.
- Evaluate under conditions close to default temperature, humidity, and pressure values (see Section 1.1 of the STCC4 datasheet) and avoid large fluctuations in environmental conditions.
- Use a reference CO_2 sensor to verify test chamber conditions (See **Section 4.1.3**).
- Perform a FRC on both the STCC4 CO_2 sensors and the reference CO_2 sensor prior to testing.
- Wait until the reference CO_2 sensor output has stabilized before changing CO_2 concentration in the test chamber. A minimum dwell time of 5 min is recommended.
- Monitor test chamber pressure to avoid overpressure when increasing CO_2 concentration and ensure overpressure can be safely released from the test chamber.

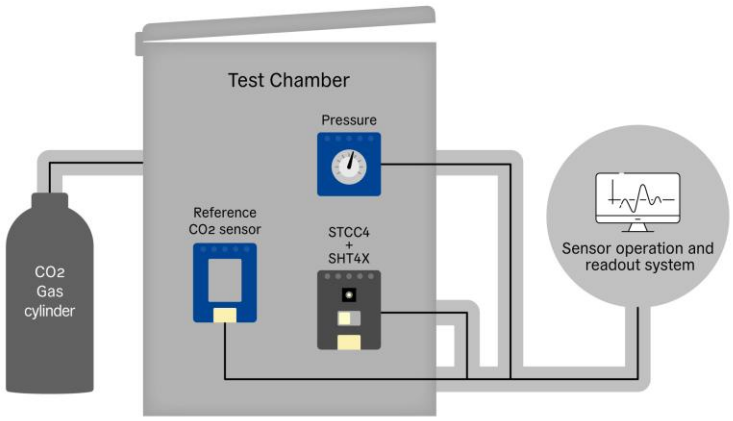

Figure 5: Example measurement setup schematic for end-of-line and sample testing. A fan can be used in the test chamber to promote a uniform gas distribution.

6 Disclaimer

This document must not be considered exhaustive and is subject to change without prior notice.

7 Revision History

Date	Version	Page(s)	Changes
May 2026	1.0	All	Initial release

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 (including death). 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 purchases or uses 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 is 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 solely warrants to the original purchaser of this product for a period of 12 months (one year) from the date of delivery that this product is 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 as sole and exclusive remedy, in SENSIRION's discretion, repair this product or send a replacement product, 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 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.

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