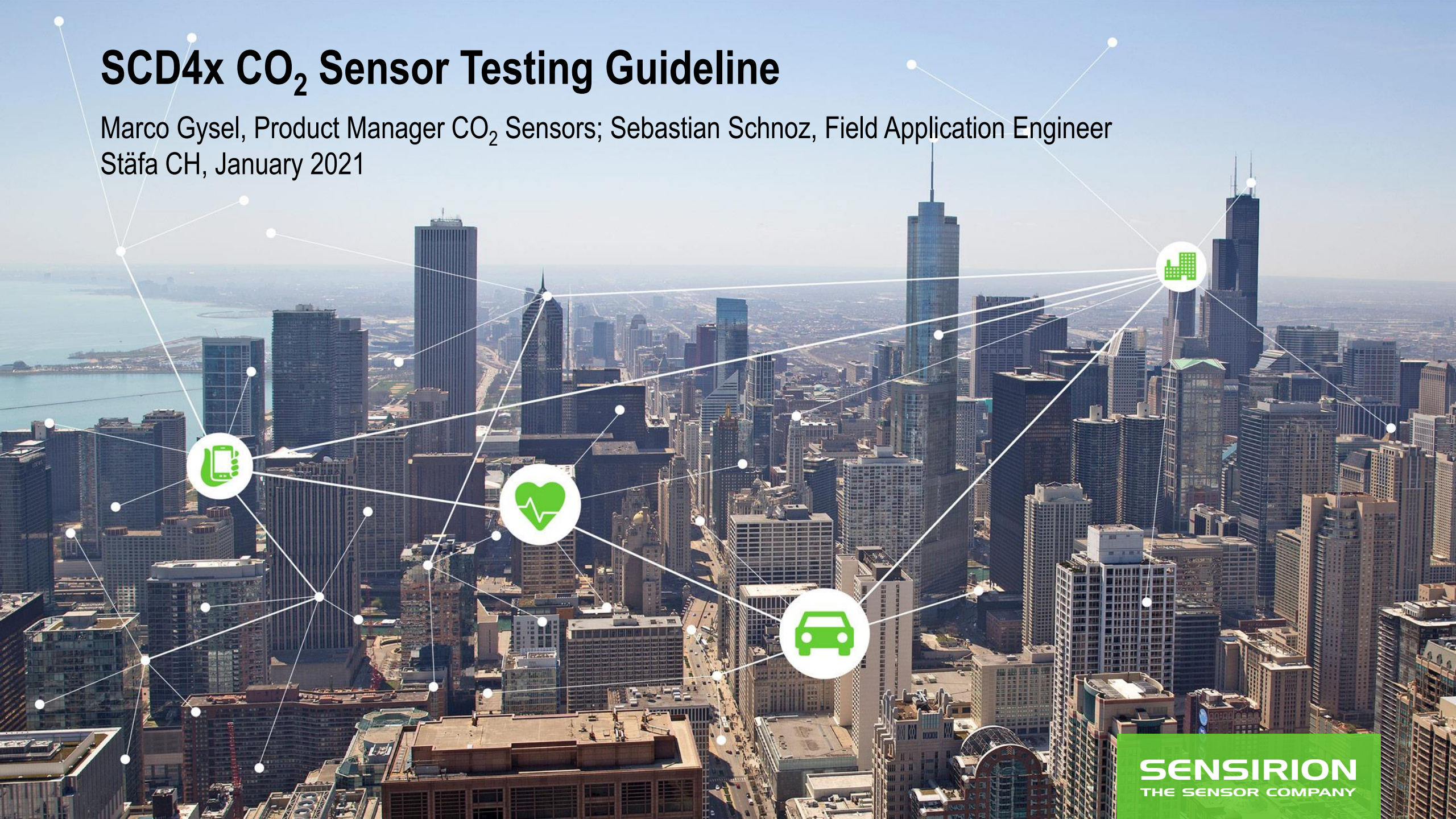


SCD4x CO₂ Sensor Testing Guideline

Marco Gysel, Product Manager CO₂ Sensors; Sebastian Schnoz, Field Application Engineer
Stäfa CH, January 2021



SCD4x Testing Guide

1. **Overview:** Most important testing recommendation

2. **Testing Sequence**

3. **Sensor Qualification**

- Qualification Sequence
- Pass / Fail Criteria

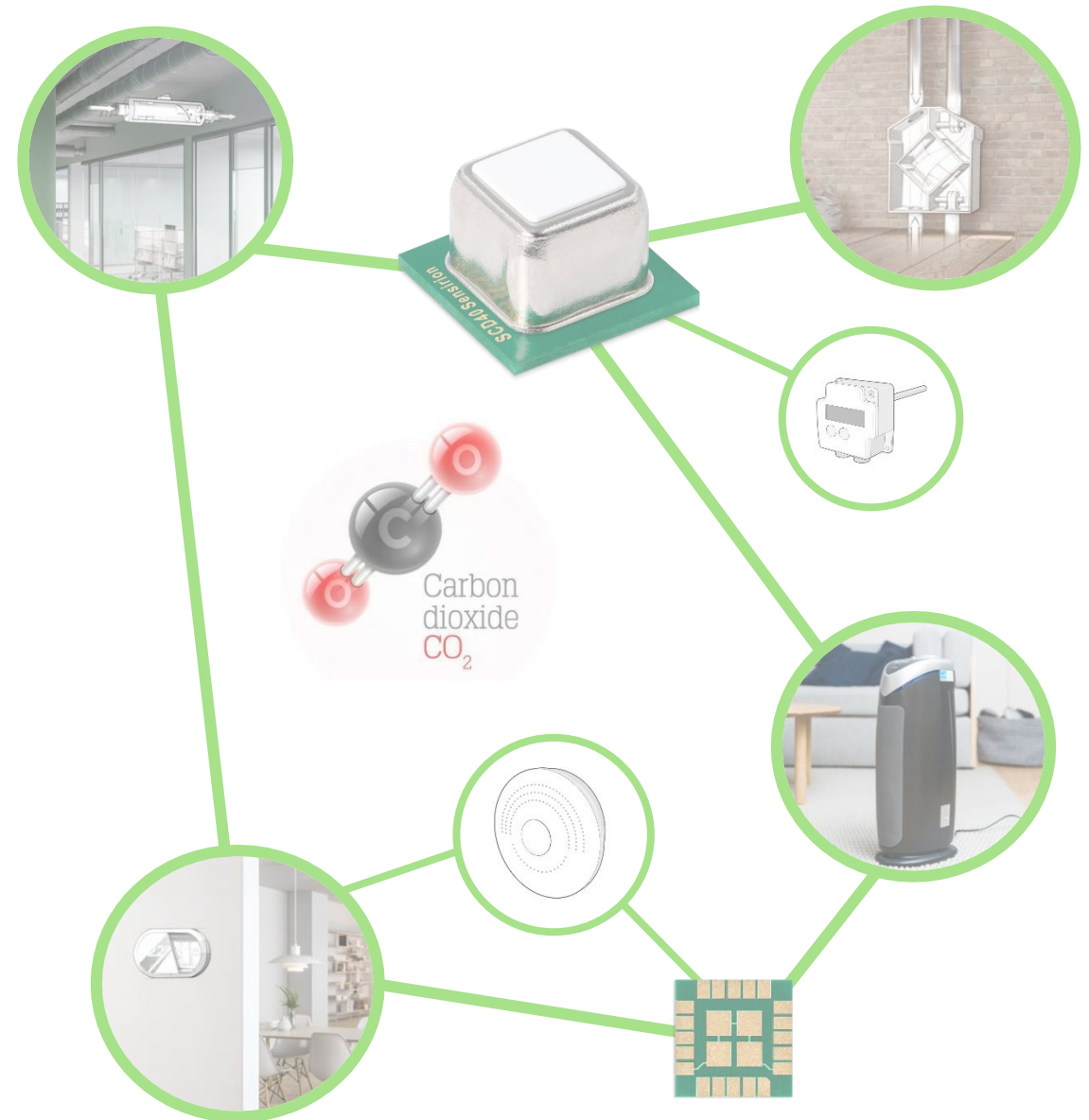
Appendix

4. **Dive-in: Forced Recalibration (FRC)**

- FRC via ControlCenter
- FRC via I2C

5. **Dive-in: Sensor Self-Test**

6. **Dive-in: Basic performance testing**



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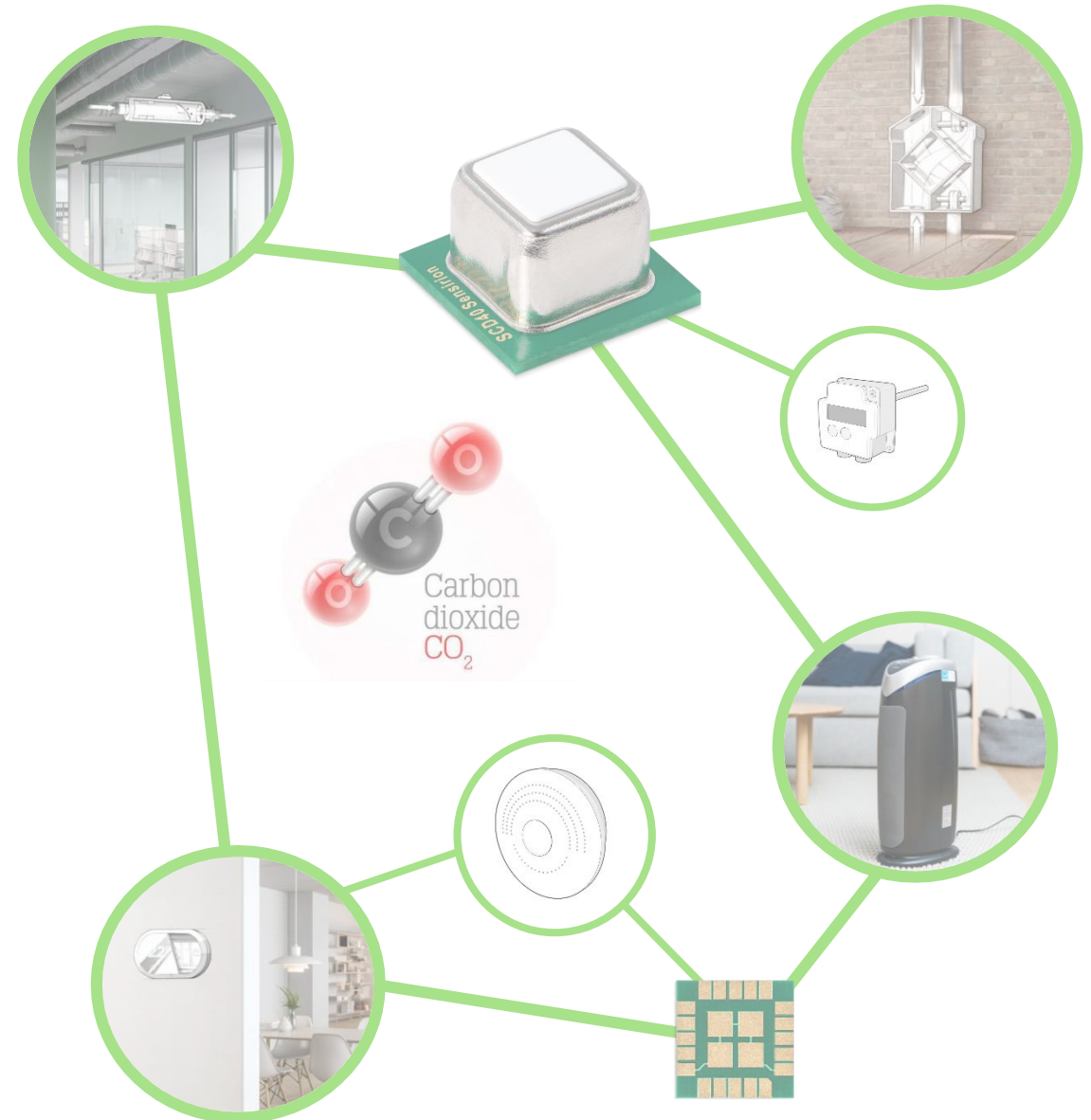
Appendix

4. Dive-in: Forced Recalibration (FRC)

- FRC via ControlCenter
- FRC via I2C

5. Dive-in: Sensor Self-Test

6. Dive-in: Basic performance testing



1. Overview: Most important testing recommendations

Recommended CO₂ reference:
Edinburgh Gascard NG 0 – 1%



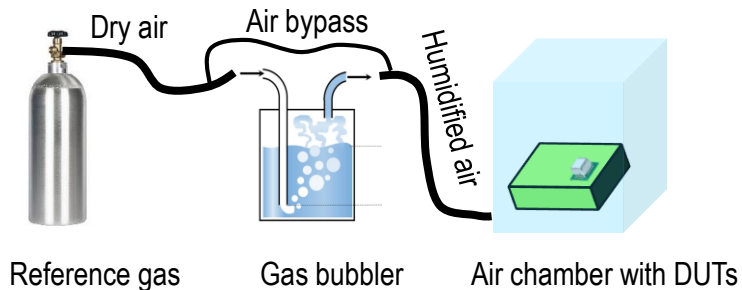
Perform Forced Recalibration
before performance testing

SCD4x
Assembly

Forced
Recalibration

Testing

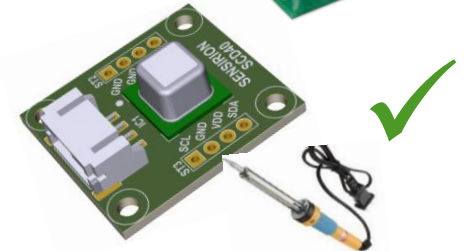
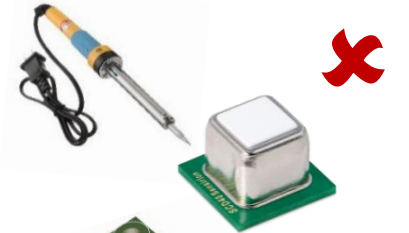
Perform performance testing at
relative humidity (RH) > 10 %



Power supply according to
peak current & stable
supply voltage (± 30 mV)



Respect moisture
sensitivity level
(MSL3) and reflow
solder parameters



SCD4x Testing Guide

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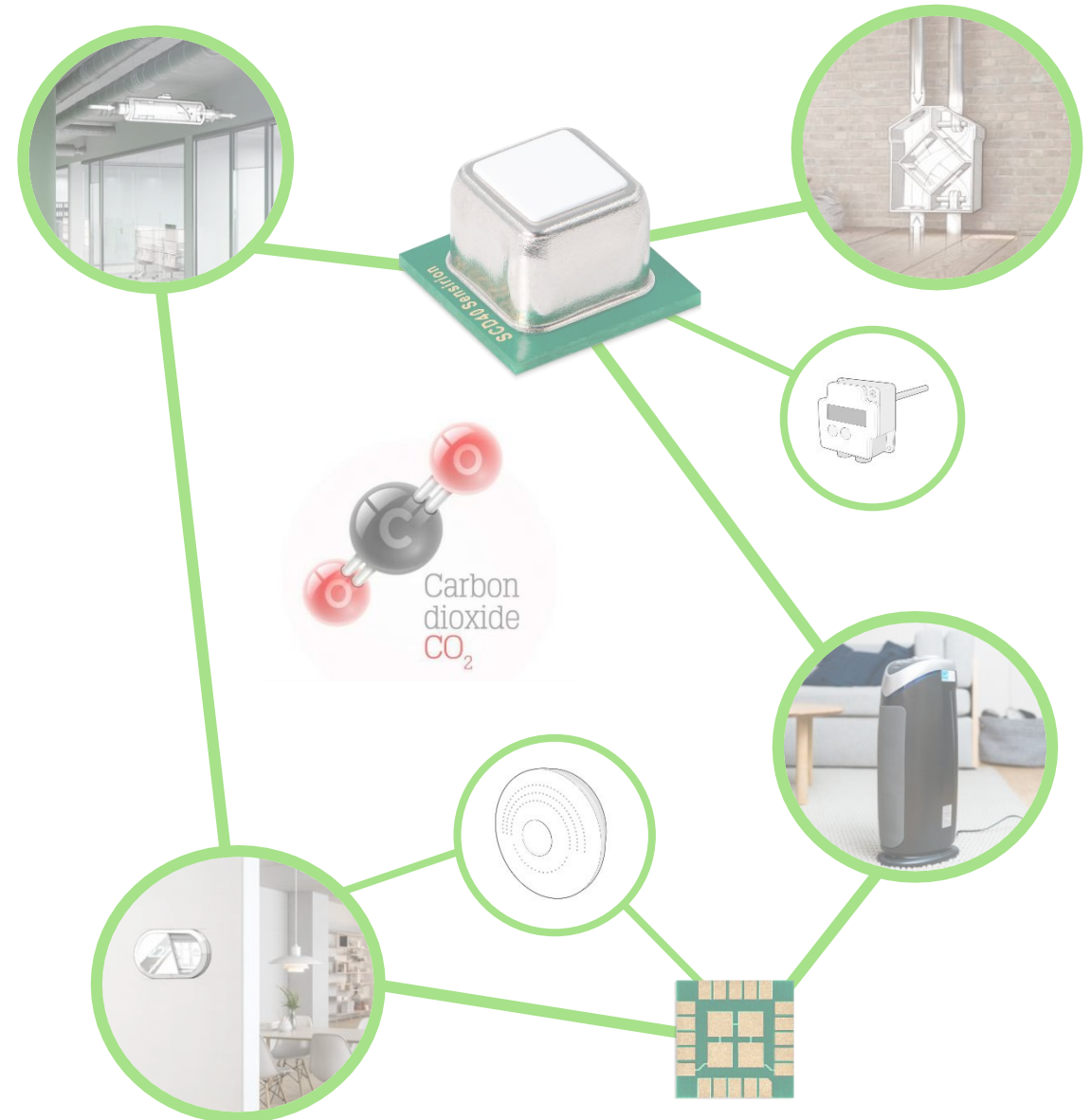
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4. Dive-in: Forced Recalibration (FRC)

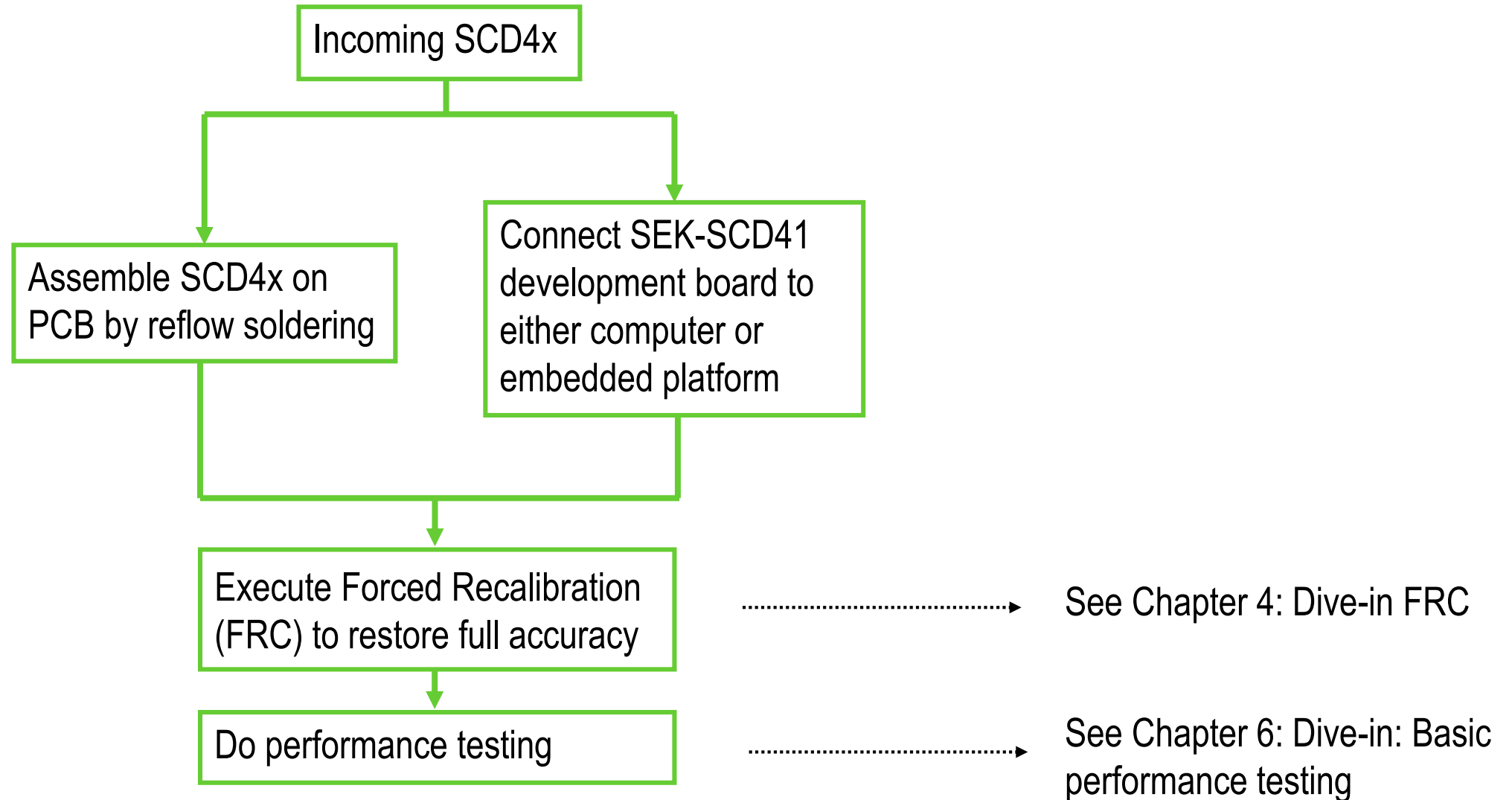
- FRC via ControlCenter
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5. Dive-in: Sensor Self-Test

6. Dive-in: Basic performance testing



2. Assembly / Testing Sequence



SCD4x Testing Guide

1. Overview: Most important testing recommendation

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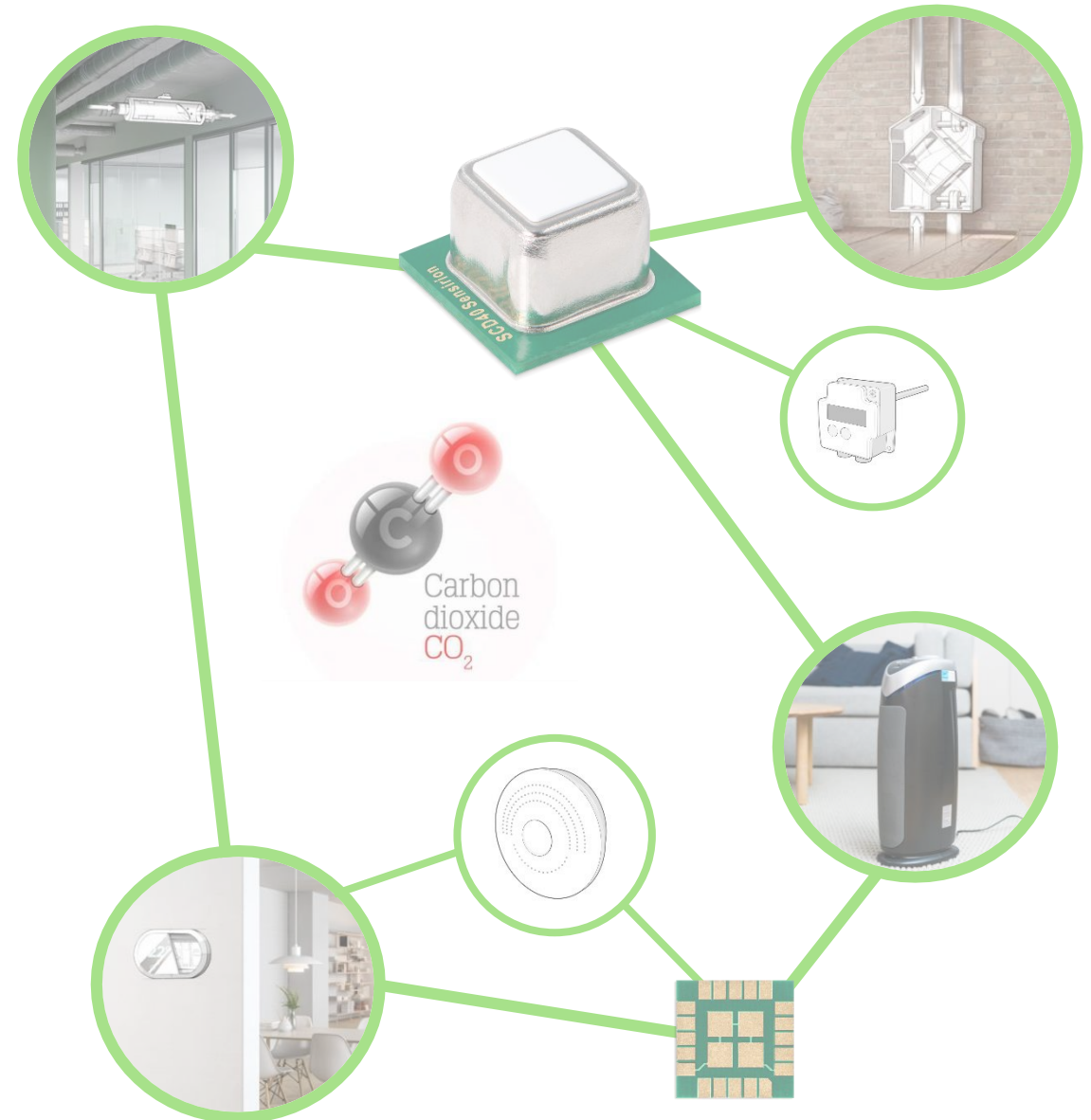
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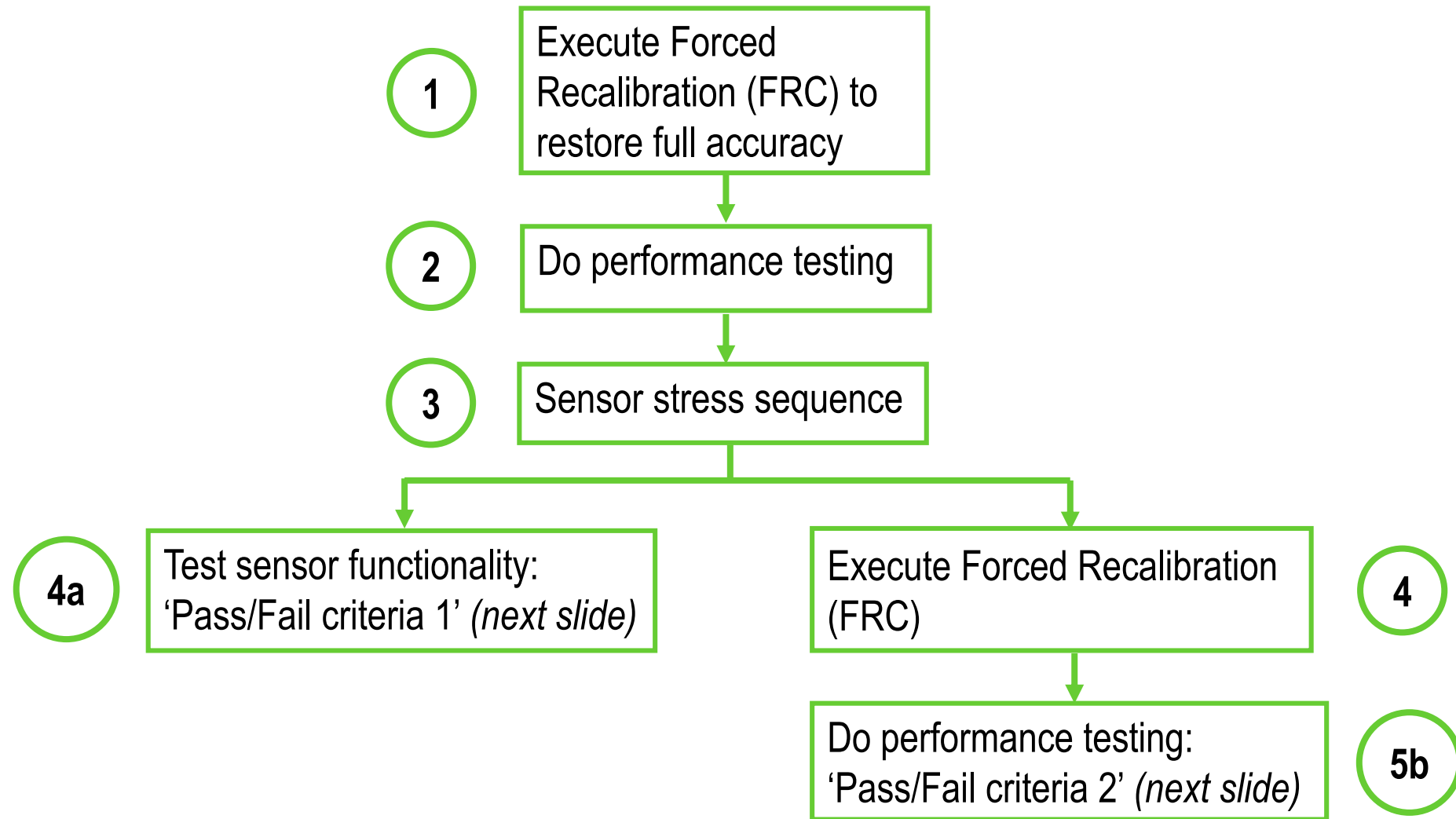
- FRC via ControlCenter
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5. Dive-in: Sensor Self-Test

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3. Sensor Qualification: Qualification Sequence



3. Sensor Qualification: Pass / Fail Criteria

4a

Pass / Fail criteria 1: No FRC applied after sensor stress sequence

Option 1: Sensor electrically intact

- Pass criteria: Sensor responds to commands

Option 2: Conduct self-test with SCD4x

- Pass criteria: No error flag detected
- See Chapter 5: Dive-in Sensor Self-Test

5b

Pass / Fail criteria 2: FRC applied after sensor stress sequence

- Compare SCD4x sensor output to reference (reference sensor or reference gas)

Pass/ fail criteria:

- Measurement within: SCD4x accuracy + specified SCD4x drift + Reference sensor accuracy
- SCD40 accuracy: $\pm (50 \text{ ppm} + 5 \% \text{ MV})$
- SCD41 accuracy: $\pm (40 \text{ ppm} + 5 \% \text{ MV})$
- Specified drift: $\pm (5 \text{ ppm} + 2 \% \text{ MV}) \times \text{simulated years}$
- Reference sensor accuracy: depends on ref. system

Example: Simulated sensor lifetime = 10 years

→ Acceptance criteria = $\pm (100 \text{ ppm} + 25 \% \text{ MV})$ + accuracy reference system

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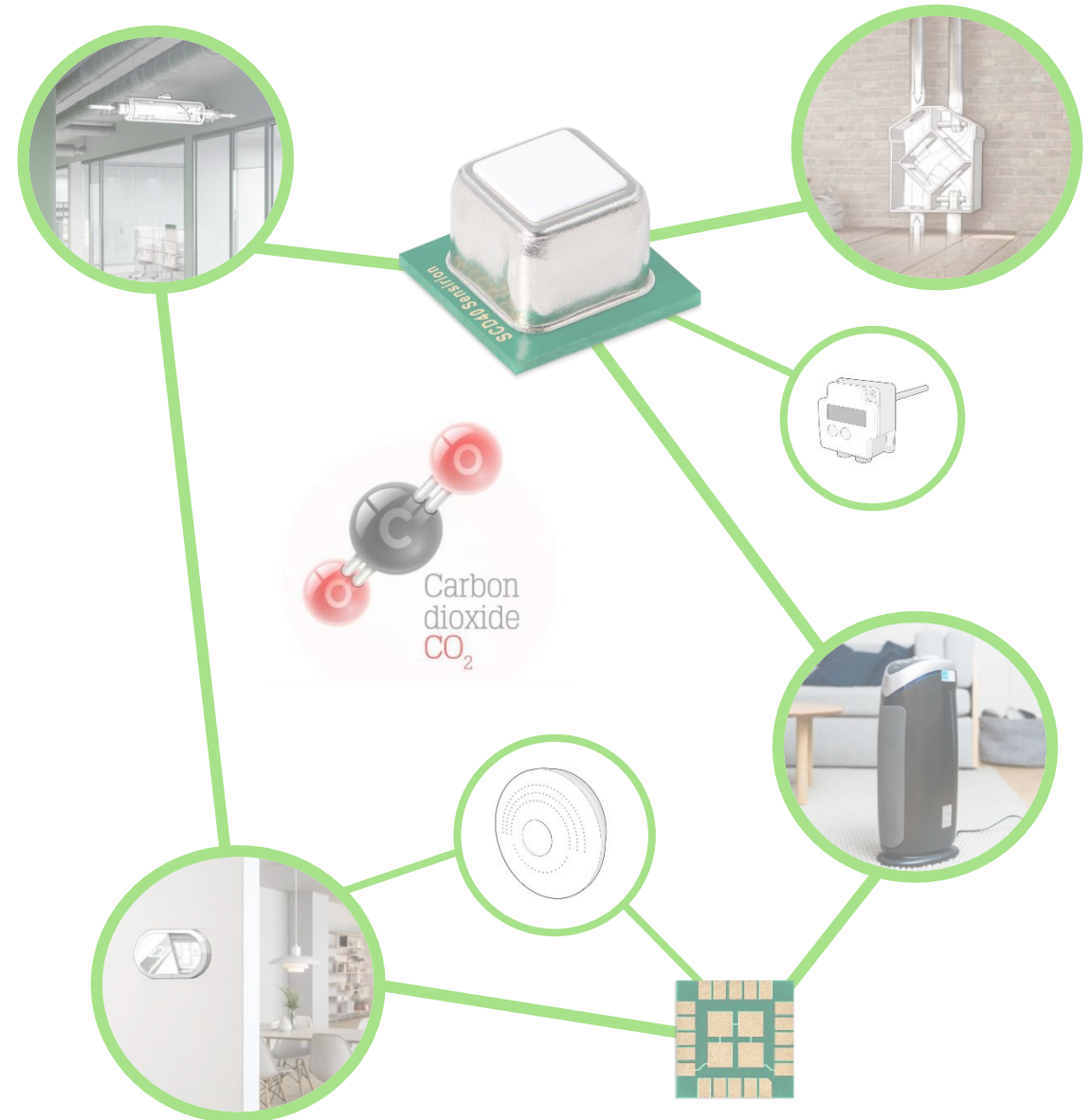
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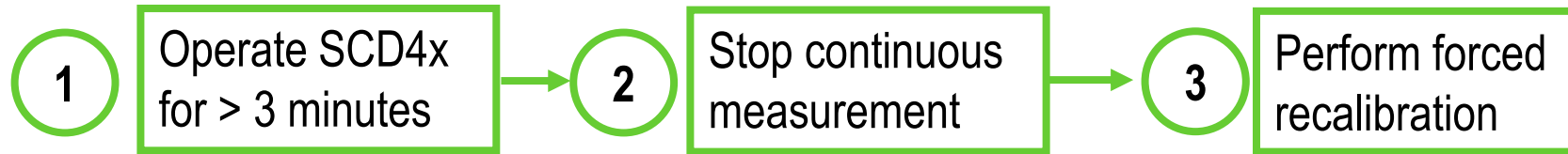
- FRC via ControlCenter
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5. Dive-in: Sensor Self-Test

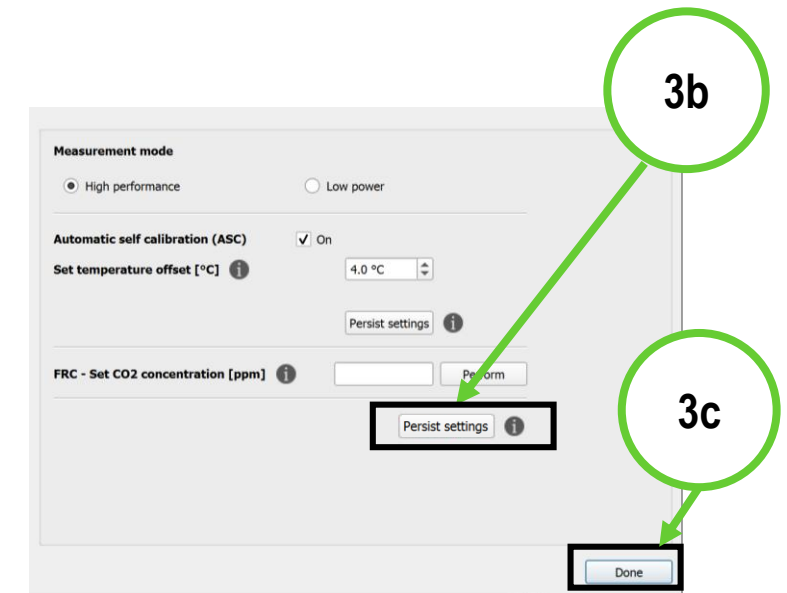
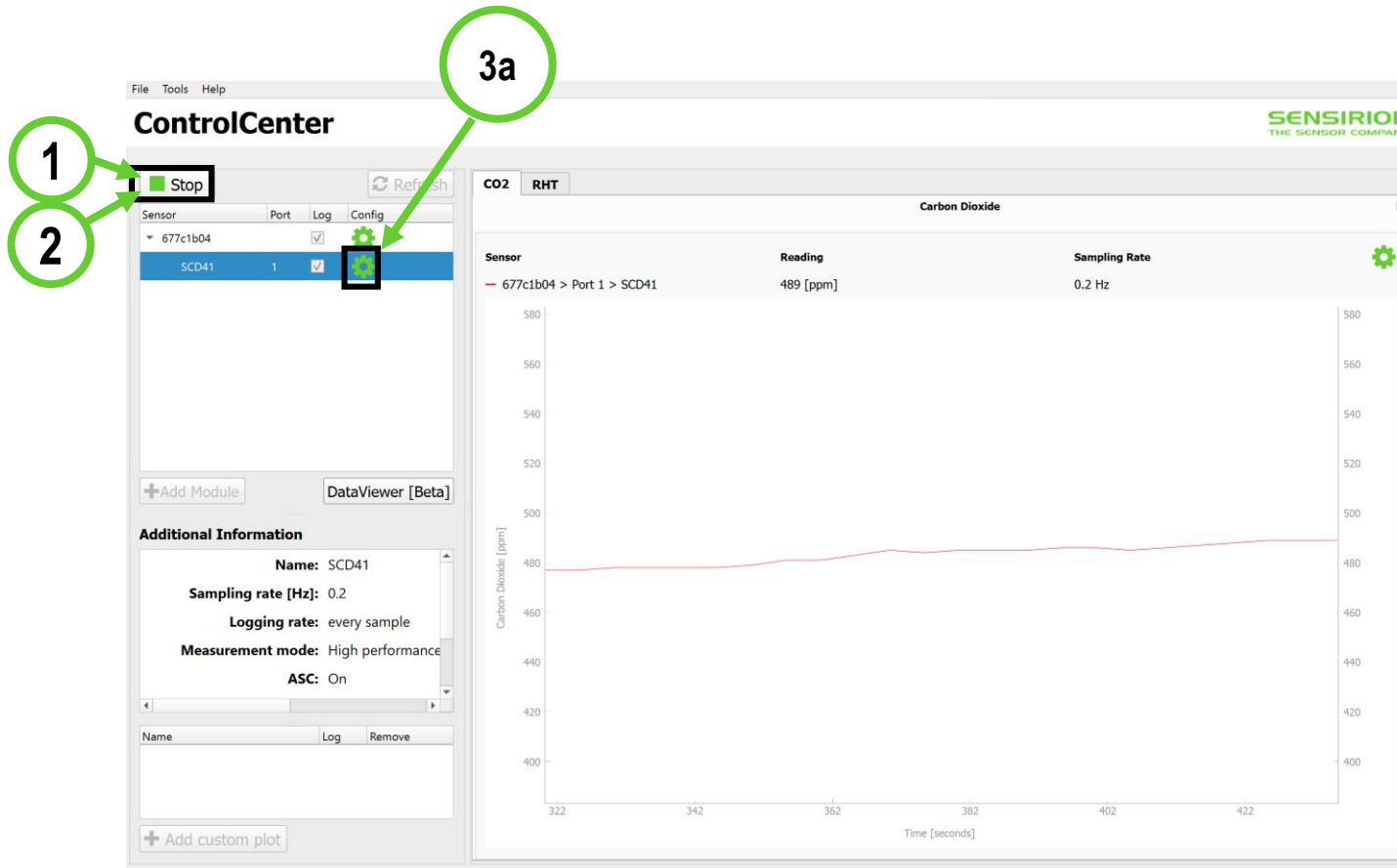
6. Dive-in: Basic performance testing



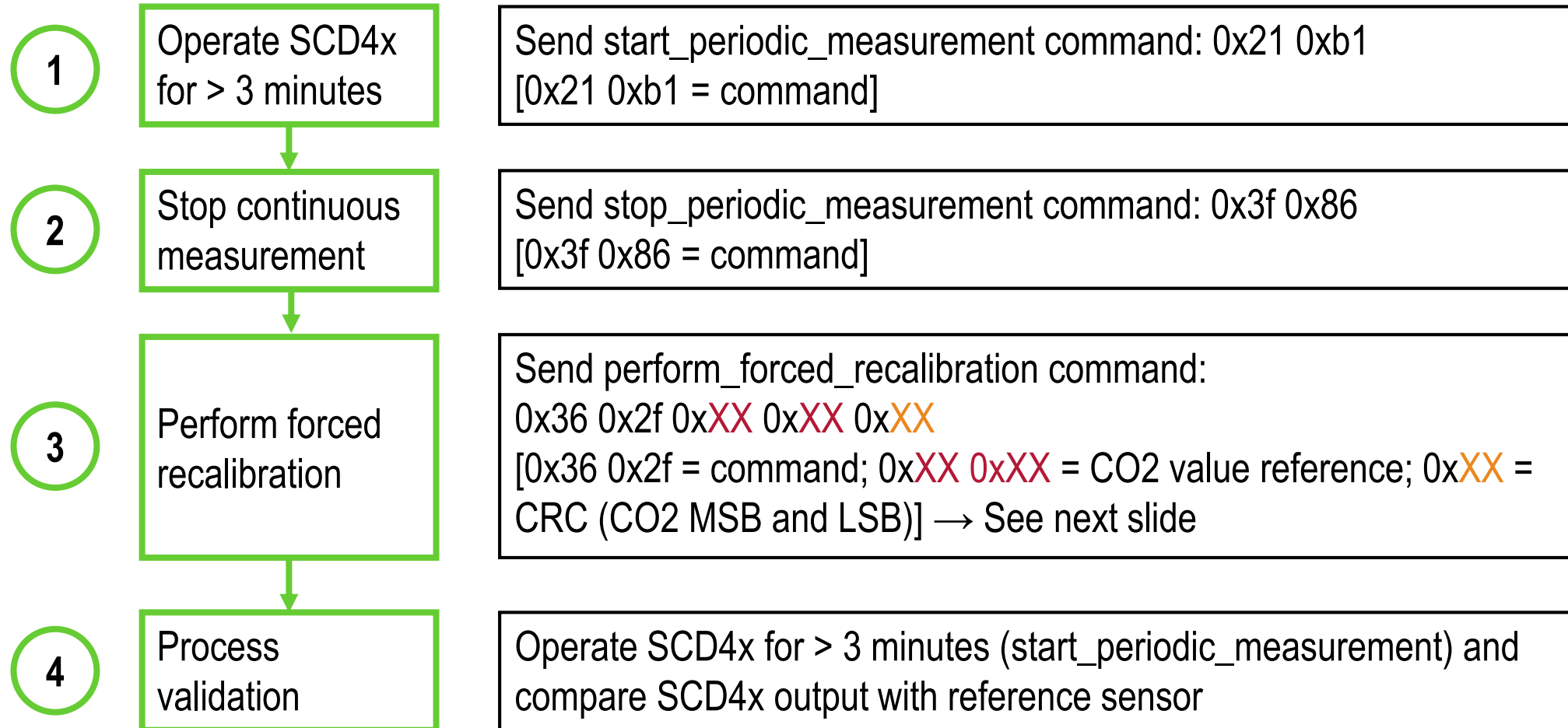
4. Dive-in: Forced Recalibration (FRC) via ControlCenter



CO₂ concentration must be constant throughout the process. Use well-calibrated reference sensor as FRC-input CO₂ concentration. **!**



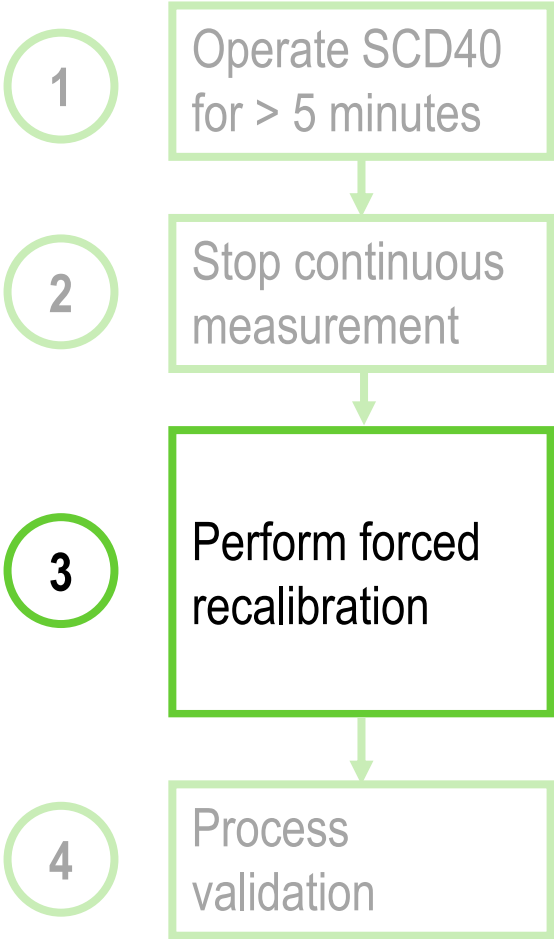
4. Dive-in: Forced Recalibration (FRC) via I2C



CO₂ concentration must be constant throughout the process. Use well-calibrated reference sensor as FRC-input CO₂ concentration.



4. Dive-in: Forced Recalibration (FRC) via I2C Example



Example

Table 18: perform_forced_rec recalibration I2C sequence description

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	Target concentration [ppm CO ₂] = word[0]	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 490 ppm					
Write (hexadecimal)	0x362f <i>Command</i>	0x01e0 <i>Input: 490 ppm</i>	0xb4 <i>CRC of 0x01e0</i>		
Wait	400 ms	<i>command execution time</i>			
Response (hexadecimal)	0x7fce <i>Response: - 50 ppm</i>	0x7b <i>CRC of 0x7fce</i>			

SCD4x Datasheet: www.sensirion.com/file/datasheet_scd4x

SCD4x Testing Guide

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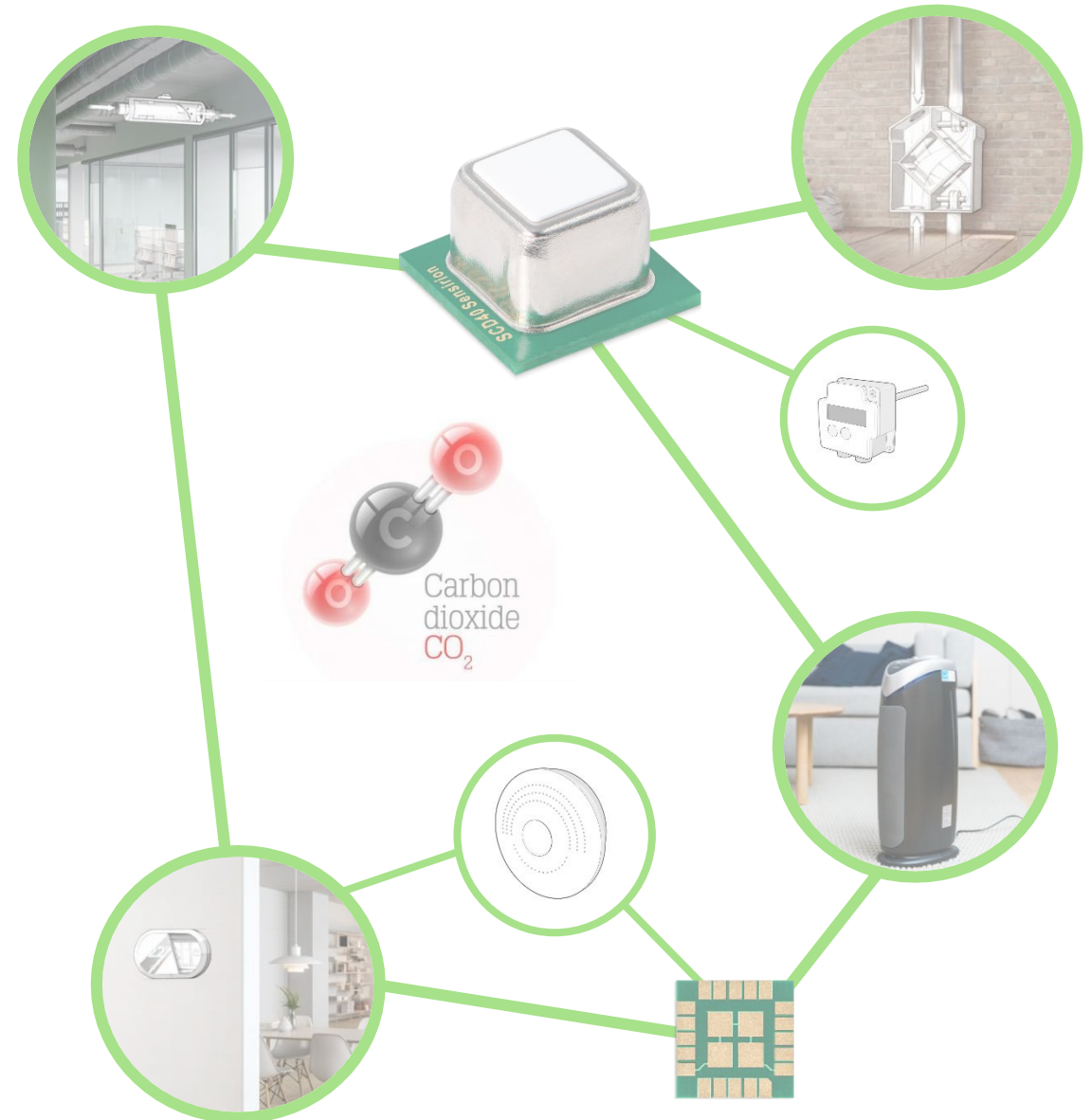
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4. Dive-in: Forced Recalibration (FRC)

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5. Dive-in: Sensor Self-Test

6. Dive-in: Basic performance testing



5. Dive-in: Sensor Self-Test

Description:

- The built-in sensor self-test feature allows to test whether the sensor is functional
- A sensor response of 0x0000 indicates that no malfunction was identified
- Any other response than 0x0000 indicates that either the sensor is malfunctioning or the supply voltage / current is unstable / not sufficient

Example

Table 25: perform_self_test I2C sequence description

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	5500
Example: perform self-test, no malfunction detected					
Write (hexadecimal)	0x3639 Command				
Wait	5500 ms	command execution time			
Response (hexadecimal)	0x0000 No malfunction detected	0x81 CRC of 0x0000			

SCD4x Datasheet: www.sensirion.com/file/datasheet_scd4x

SCD4x Testing Guide

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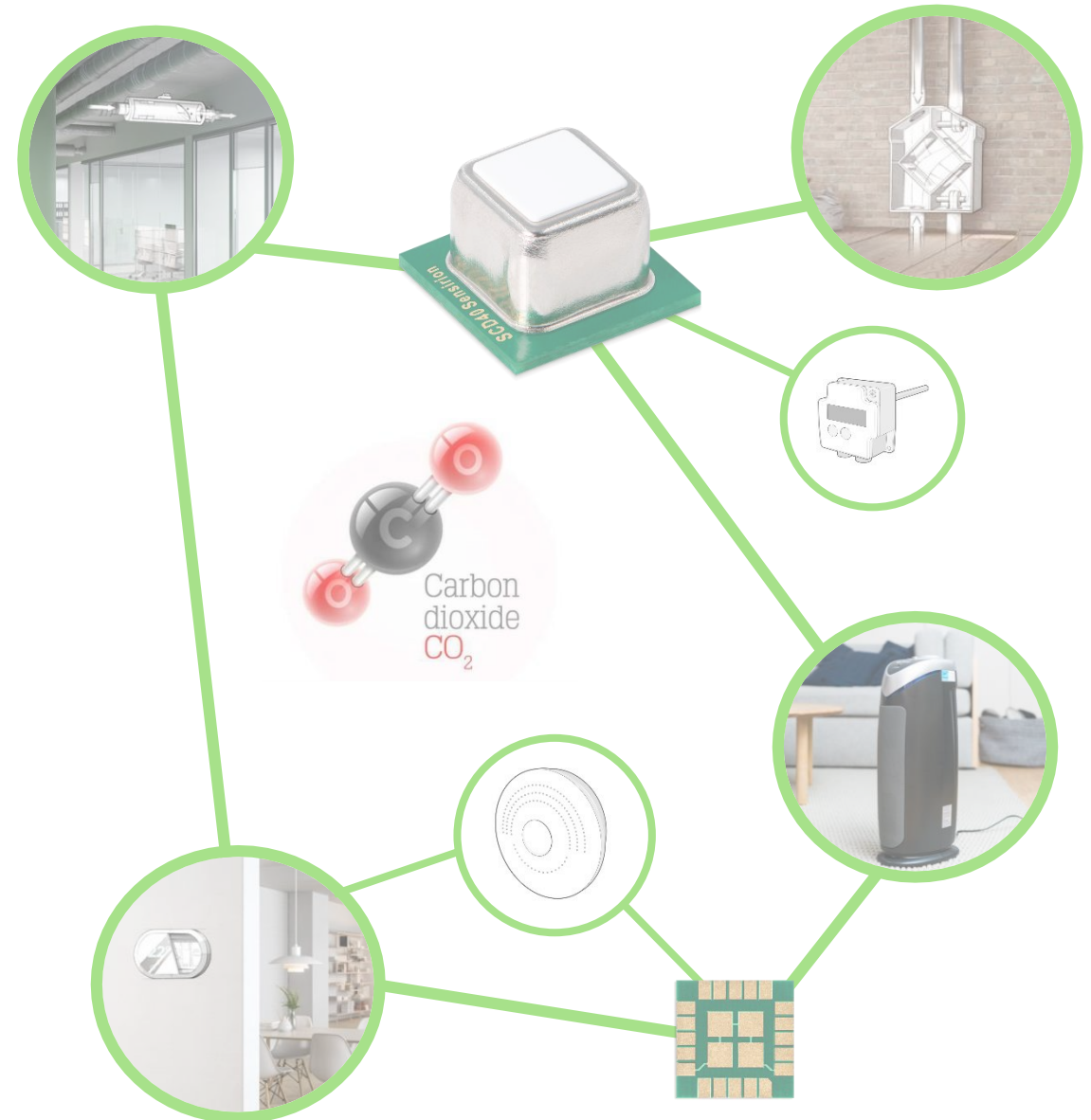
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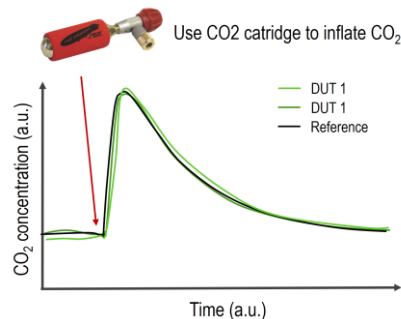
6. Dive-in: Basic performance testing

CO₂ concentration-jump with reference

Set-up: Place SCD4x sensors and reference sensor inside closed air chamber or box

Procedure:

1. Perform FRC with the DUTs
2. Start and record measurement
3. Inject CO₂ (100 %, no air mixture) into the air chamber to realize higher concentration (ideally 3k – 5k ppm)
4. Allow CO₂ to slowly diffuse out of the box

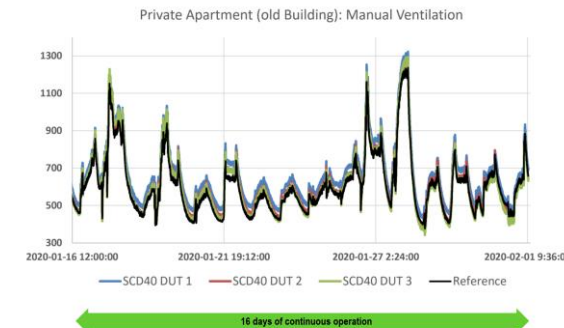


Field study with reference sensor

Set-up: Place SCD4x sensors and reference sensor inside a confined room that is sometimes occupied by people

Procedure:

1. Perform FRC with the DUTs
2. Start and record measurement
3. Let the sensors run for several days / weeks



SENSIRION

THE SENSOR COMPANY

www.sensirion.com

Recommended CO₂ Reference: Edinburgh Gascard NG 0 – 1%

Where to take reference value from?

- Having a good reference value is crucial!

Options:

- Sealed environment with known concentration in range 400 ppm – 2000 ppm
- Open space with a good reference sensor
 - Keep away from sources and drains (humans, windows, ventilation)
 - Put reference sensor close to SCD4x
 - Good reference. Recommendation:
 - Edinburgh Gascard NG 0 – 1% & gas bottles with certified CO₂ concentration at 0 and 10000 ppm for recalibration.

