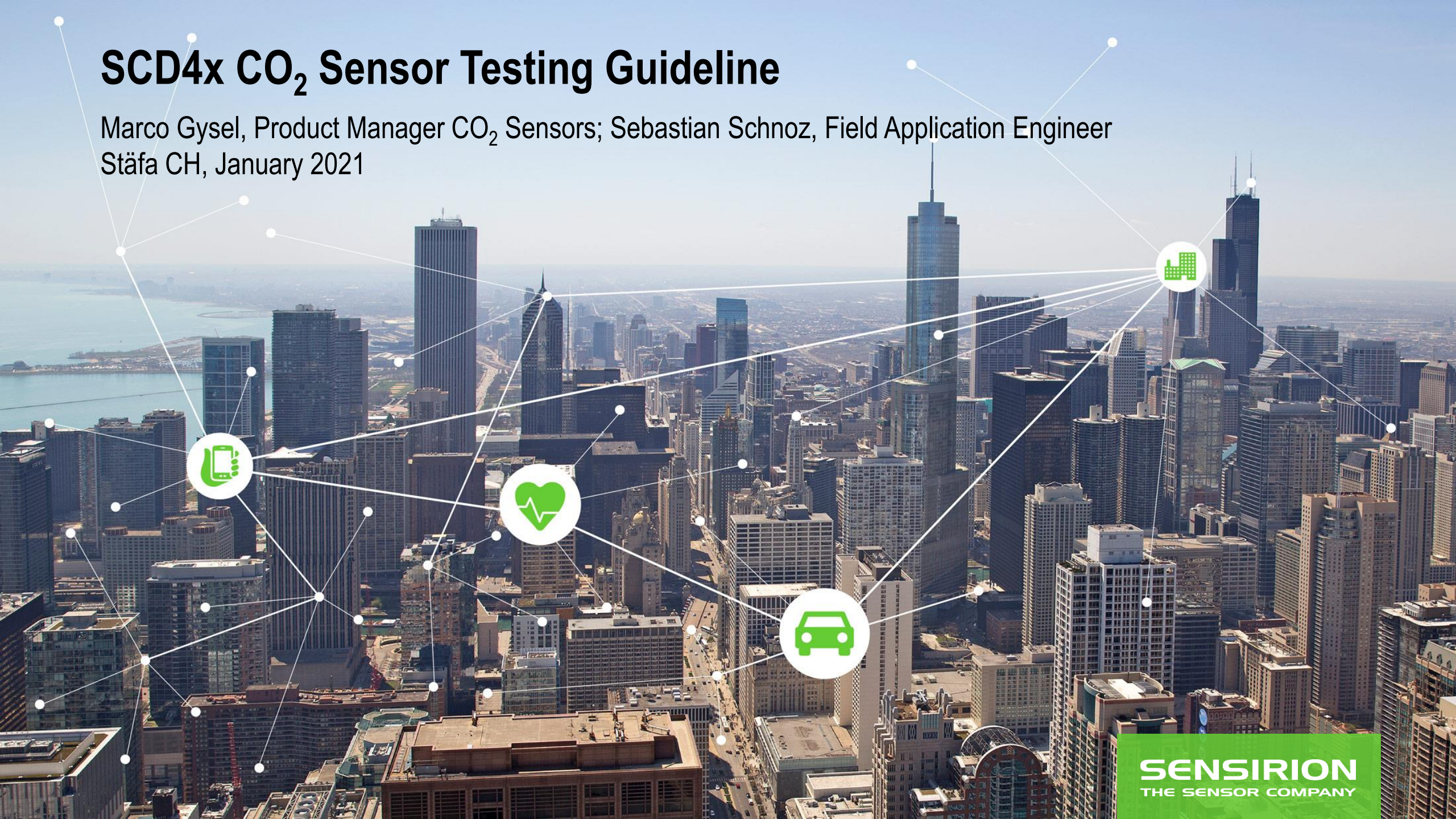
SCD4x CO_2 Sensor Testing Guideline

Marco Gysel, Product Manager CO_2 Sensors; Sebastian Schnoz, Field Application Engineer
Stäfa CH, January 2021



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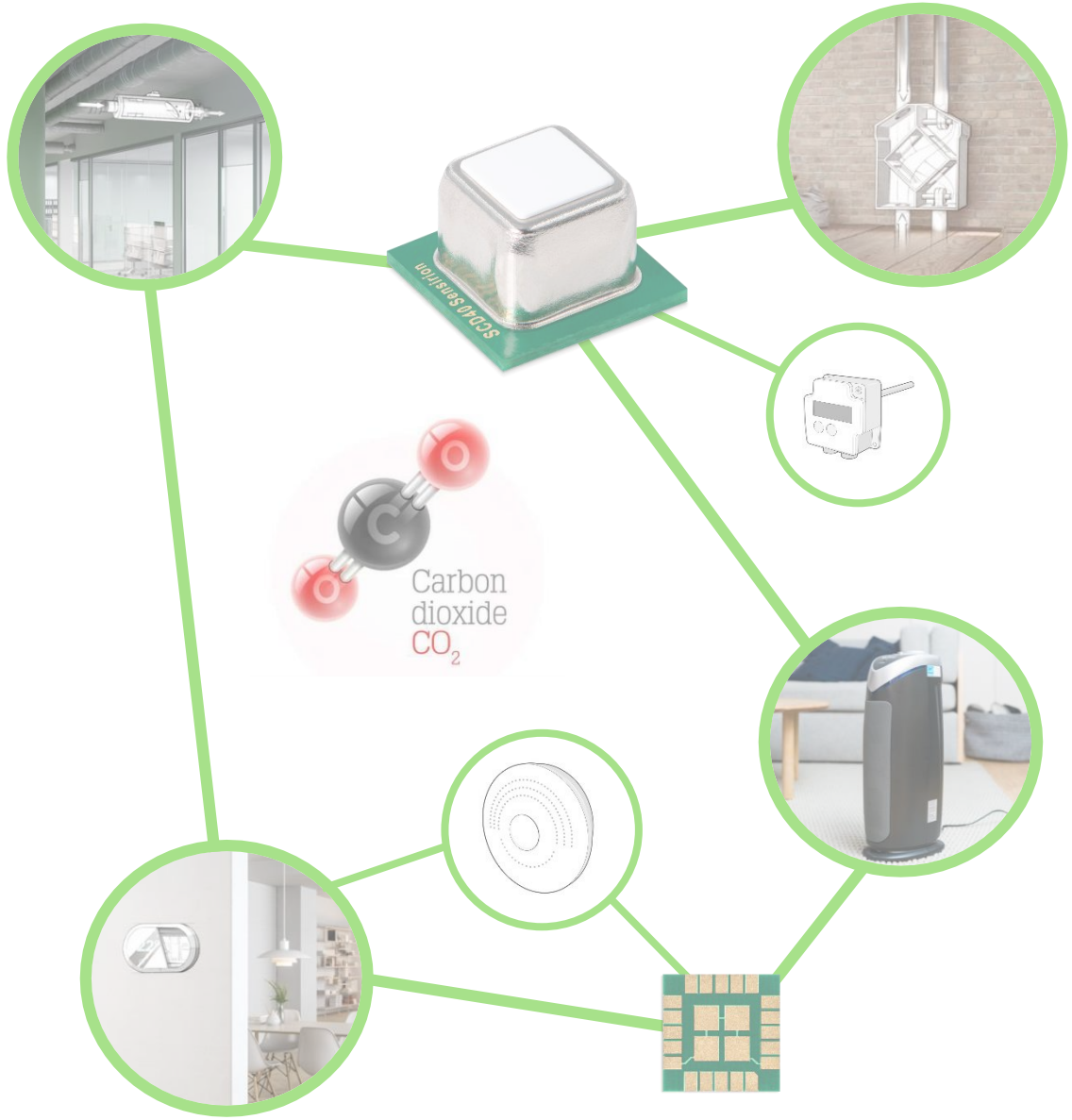
1. **Overview:** Most important testing recommendation
2. **Testing Sequence**
3. **Sensor Qualification**
   - Qualification Sequence
   - Pass / Fail Criteria

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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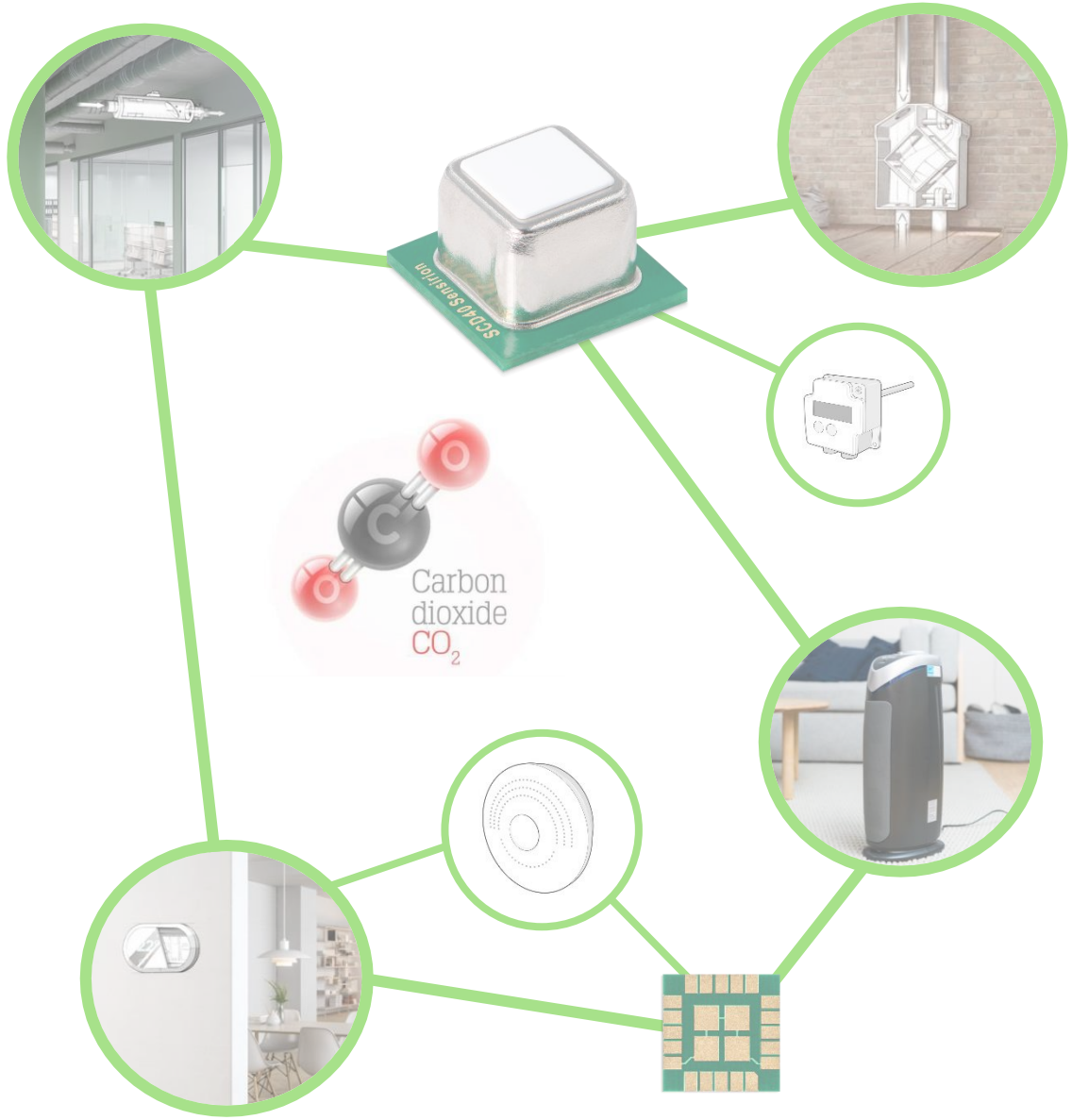

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1. Overview: Most important testing recommendations

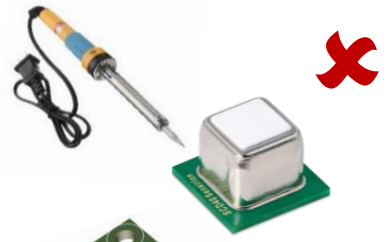
Recommended CO_2 reference:
Edinburgh Gascard NG 0 – 1%

✓

Perform Forced Recalibration
before performance testing

SCD4x Assembly → **Forced Recalibration** → **Testing**

Respect moisture sensitivity level **(MSL3) and reflow solder parameters**



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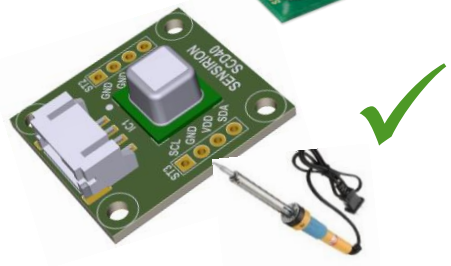
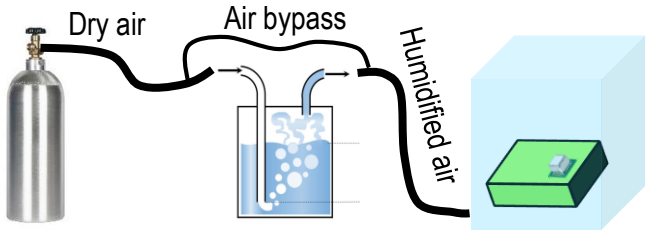


✓

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



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

✗

✓

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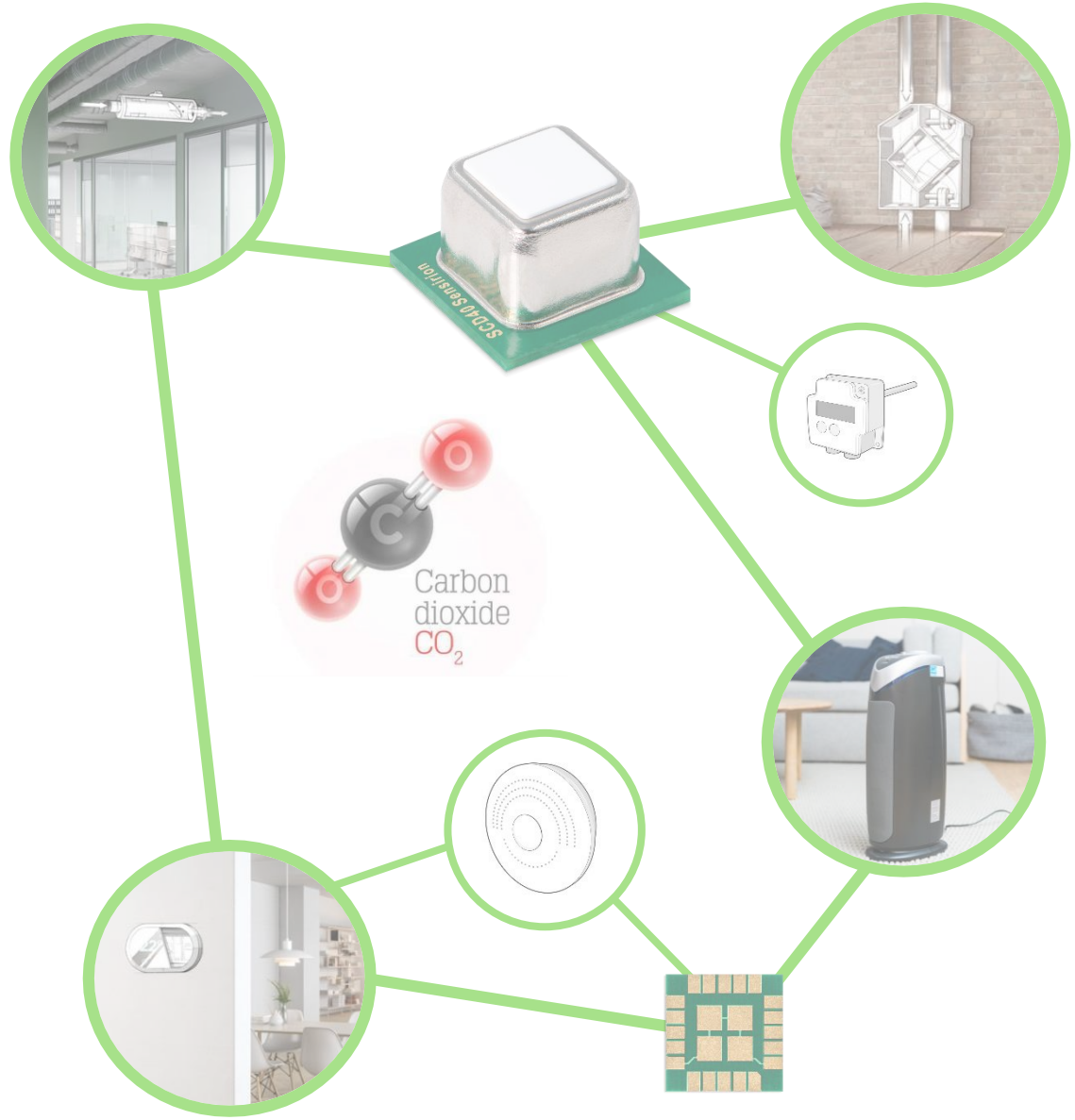
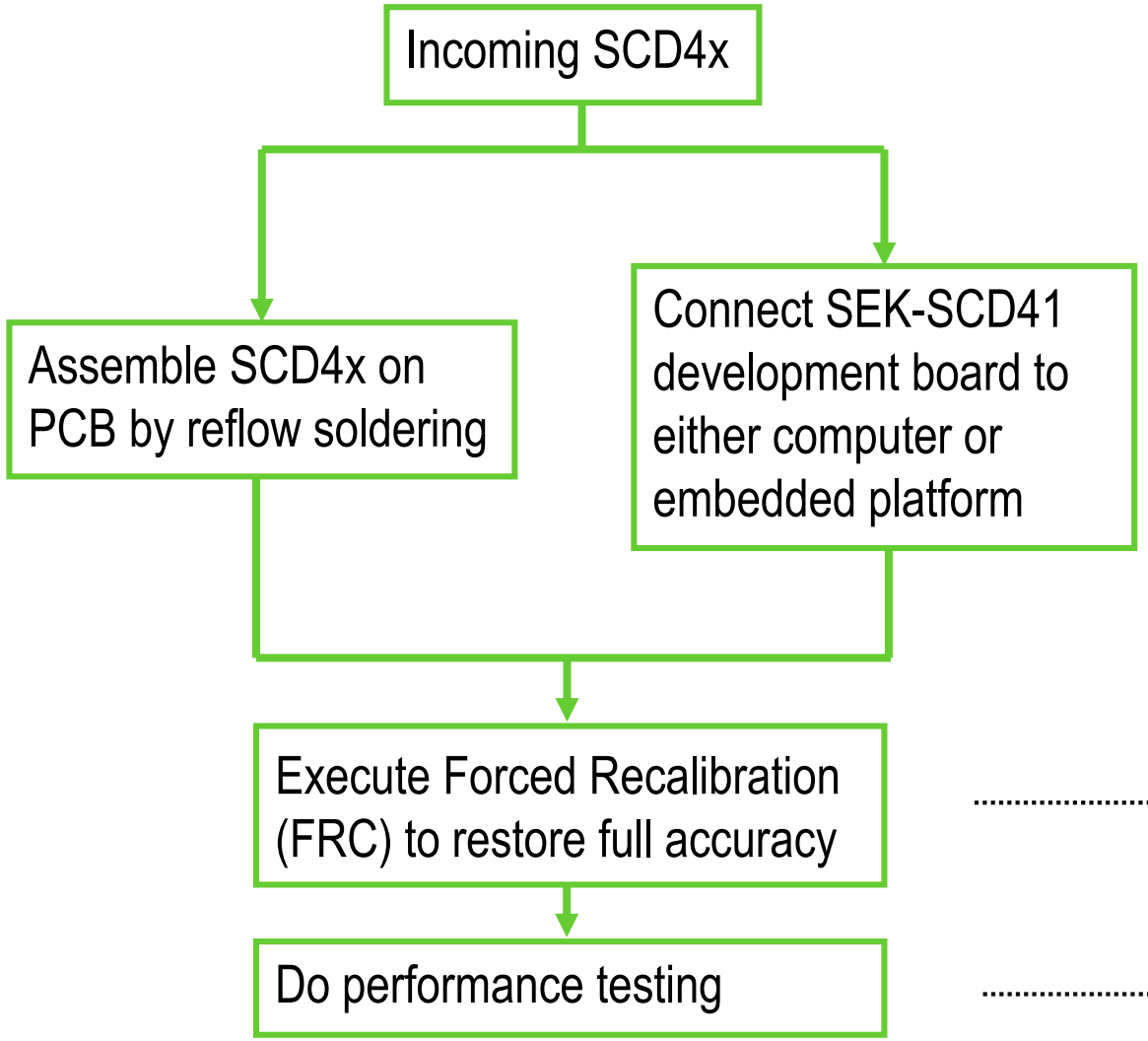


2. Assembly / Testing Sequence



See Chapter 4: Dive-in FRC

See Chapter 6: Dive-in: Basic performance testing

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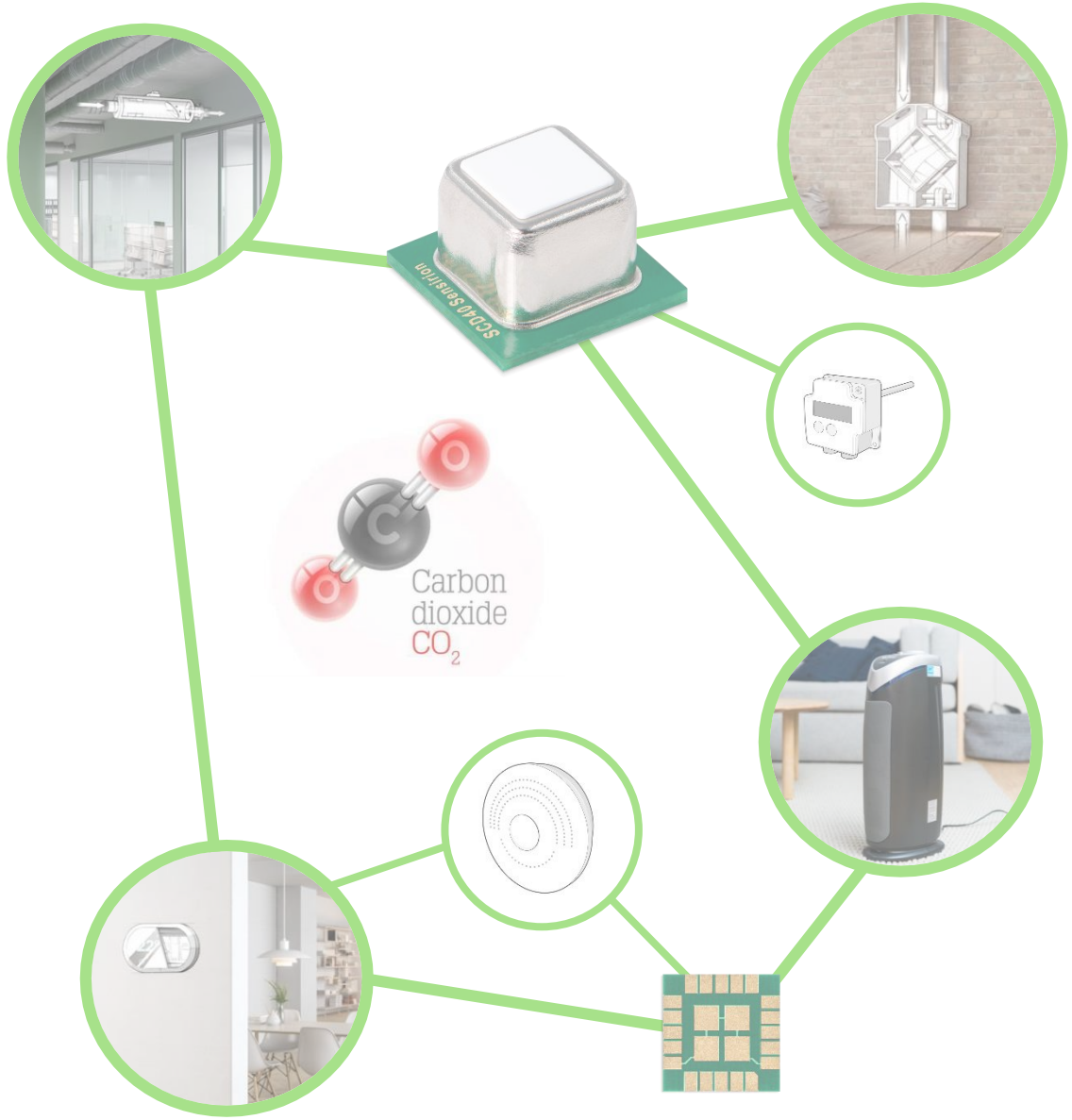

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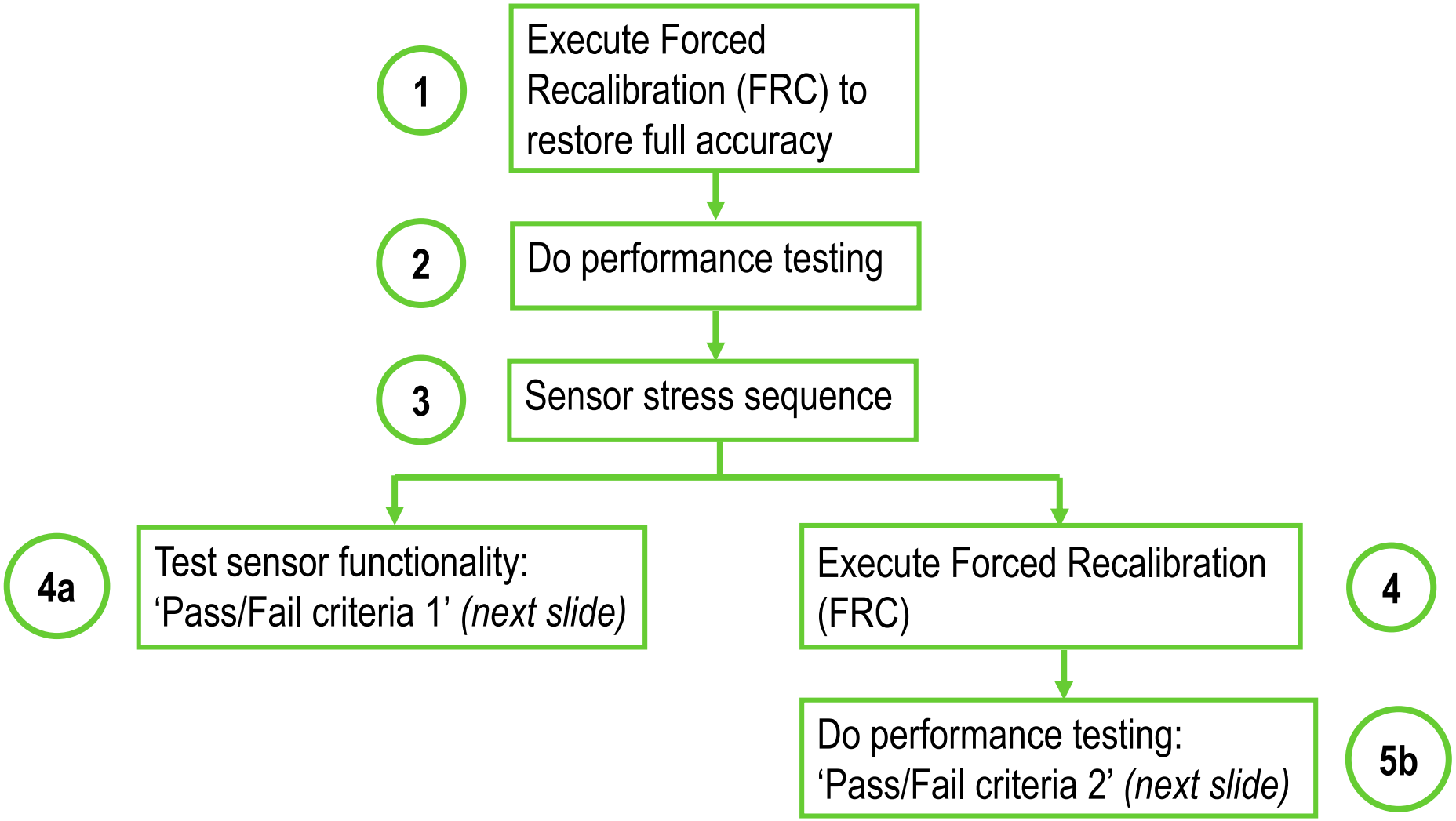
3. Sensor Qualification: Qualification Sequence



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: ± (50 ppm + 5 % MV)
- SCD41 accuracy: ± (40 ppm + 5 % MV)
- Specified drift: ± (5 ppm + 2 % MV)*simulated years
- Reference sensor accuracy: depends on ref. system

Example: Simulated sensor lifetime = 10 years
→ Acceptance criteria = ± (100 ppm + 25 % MV) + accuracy reference system

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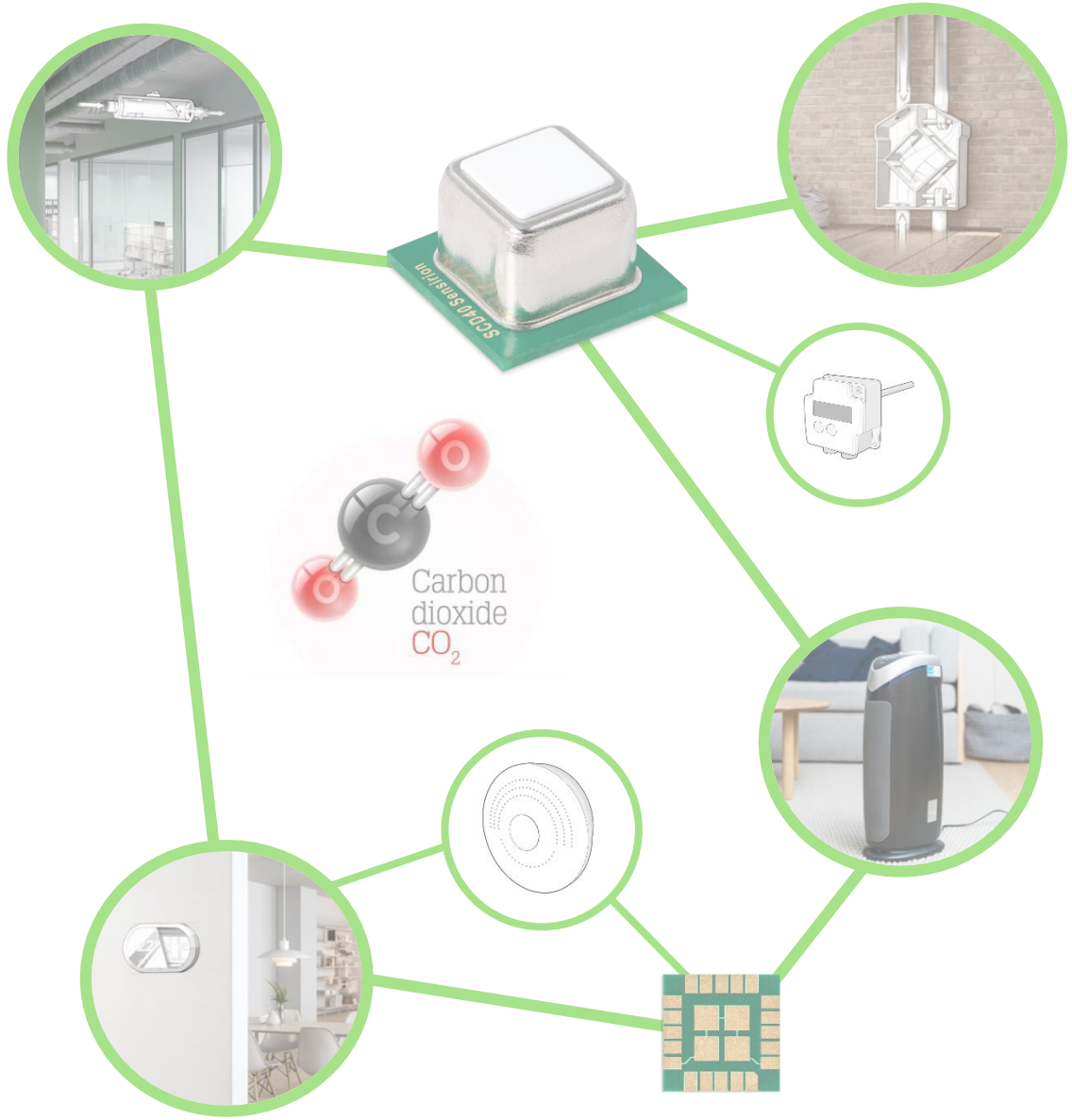

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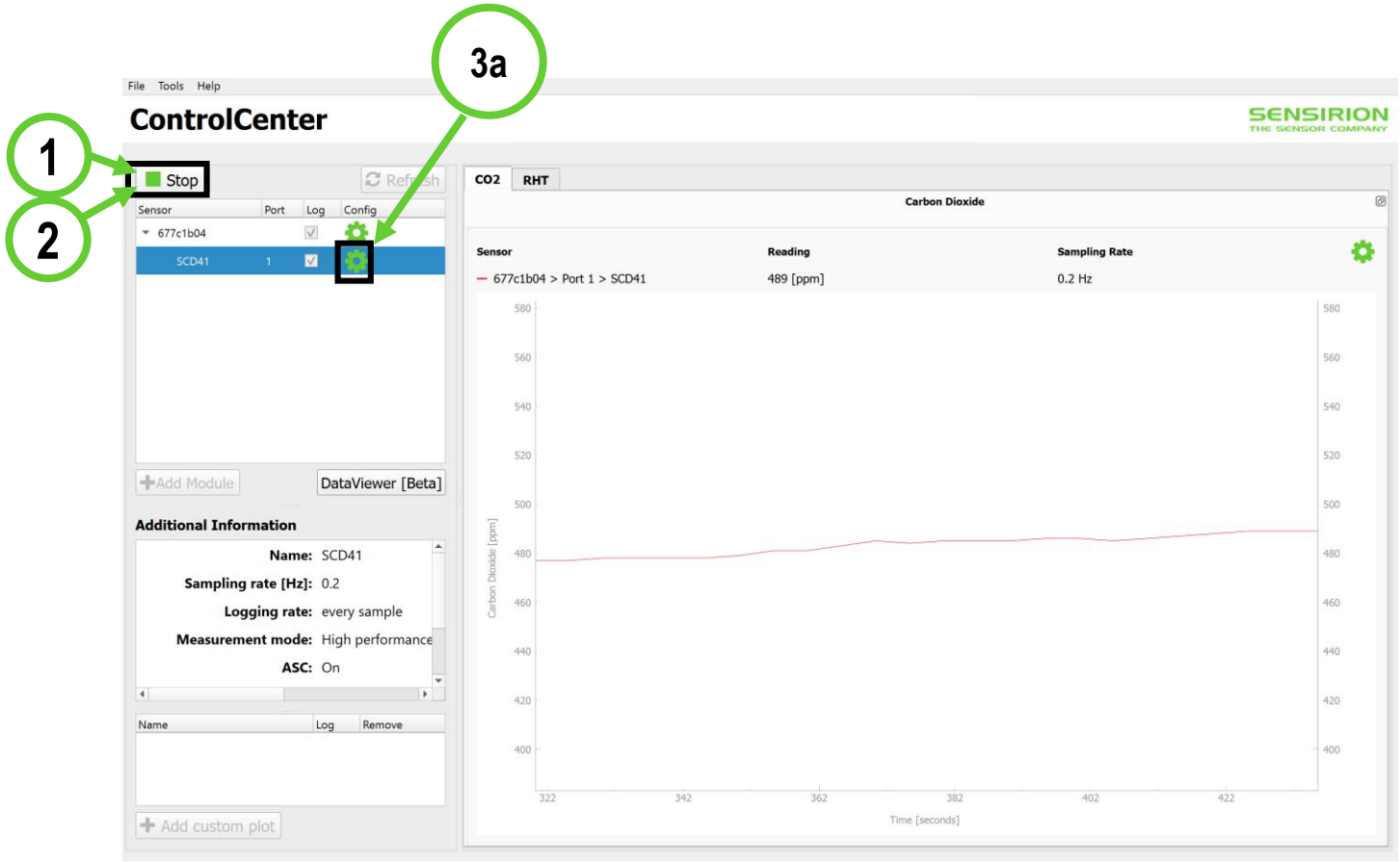
4. Dive-in: Forced Recalibration (FRC) via ControlCenter

1. Operate SCD4x for > 3 minutes
2. Stop continuous measurement
3. Perform forced recalibration

CO_2 concentration must be constant throughout the process. Use well-calibrated reference sensor as FRC-input CO_2 concentration.



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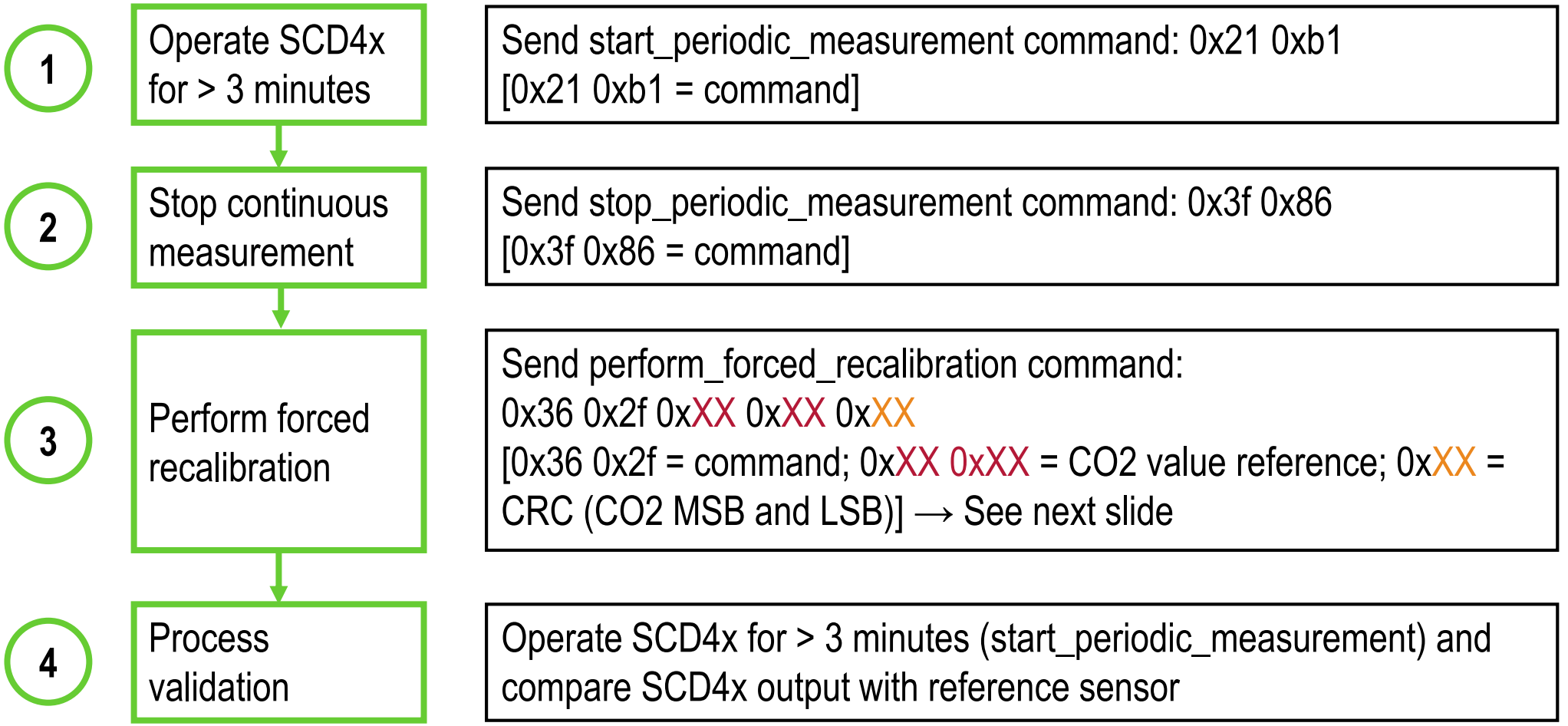

CO_2 concentration must be constant throughout the process. Use well-calibrated reference sensor as FRC-input CO_2 concentration.

!

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

1. Operate SCD40 for > 5 minutes
2. Stop continuous measurement
3. **Perform forced recalibration**
4. Process validation

Example

Table 18: perform_forced_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] = 0xfff in case of failed FRC	400
Example: perform forced recalibration, reference CO_2 concentration is 490 ppm					
Write	0x362f	0x01e0	0xb4		
(hexadecimal)	*Command*	*Input: 490 ppm*	*CRC of 0x01e0*		
Wait	400 ms	*command execution time*			
Response	0x7fce	0x7b			
(hexadecimal)	*Response: - 50 ppm*	*CRC of 0x7fce*			

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

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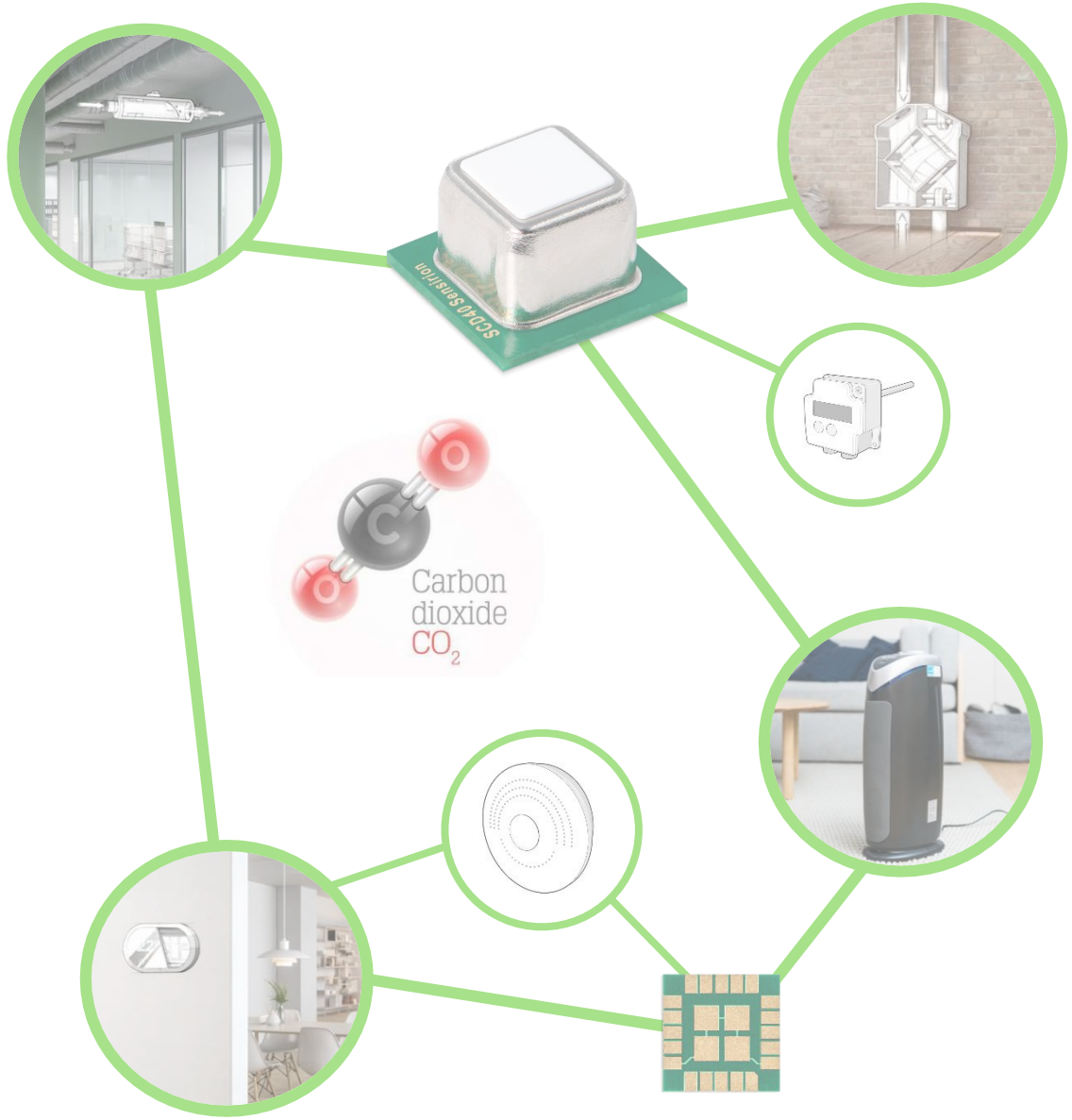

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5. Dive-in: Sensor Self-Test

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	0x3639				
(hexadecimal)	*Command*				
Wait	5500 ms	*command execution time*			
Response	0x0000		0x81		
(hexadecimal)	*No malfunction detected*		*CRC of 0x0000*		

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

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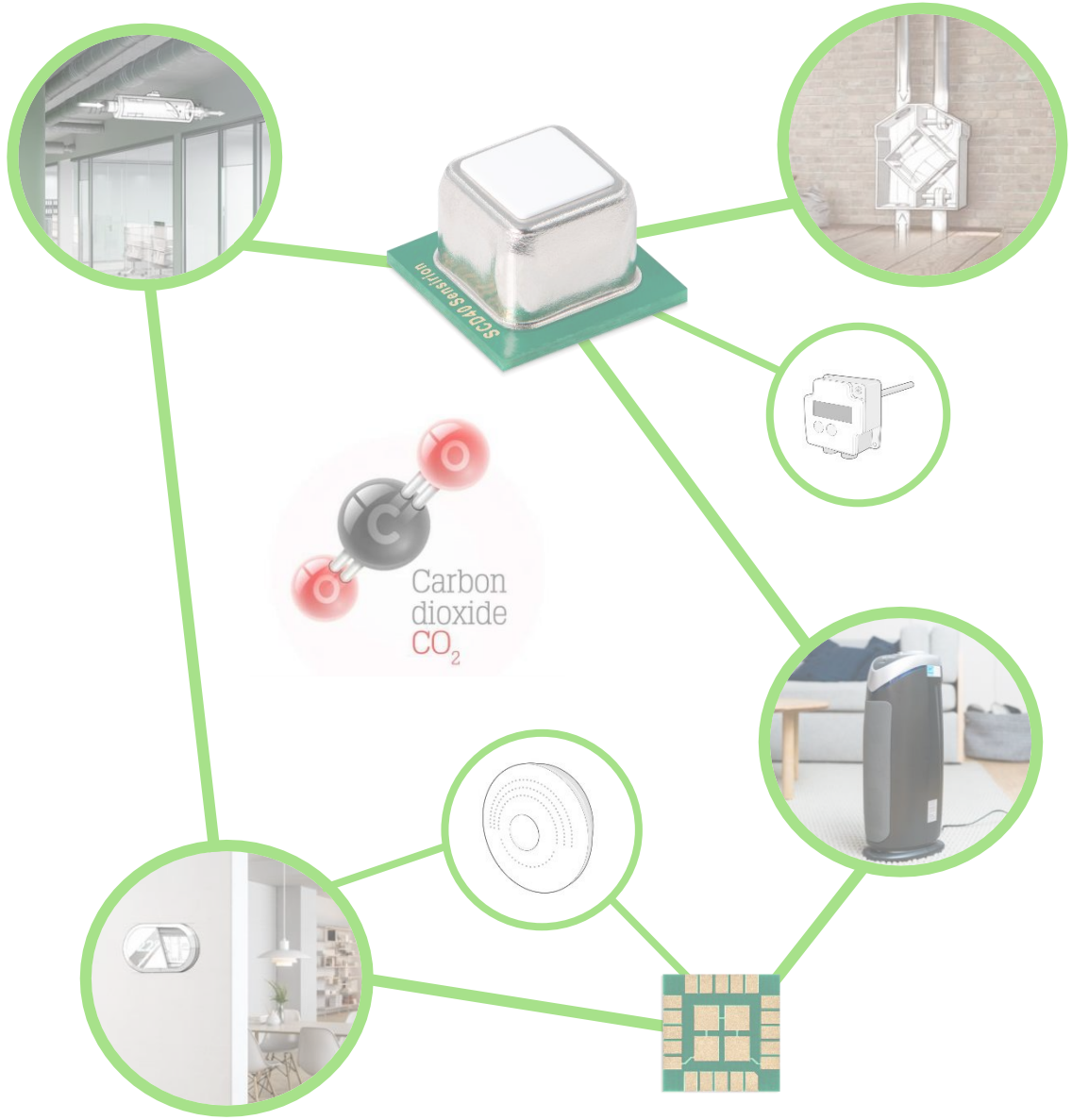


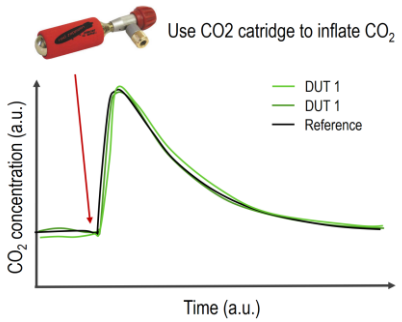
6. Dive-in: Basic performance testing

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 CO_2 (100 %, no air mixture) into the air chamber to realize higher concentration (ideally 3k – 5k ppm)
4. Allow CO_2 to slowly diffuse out of the box

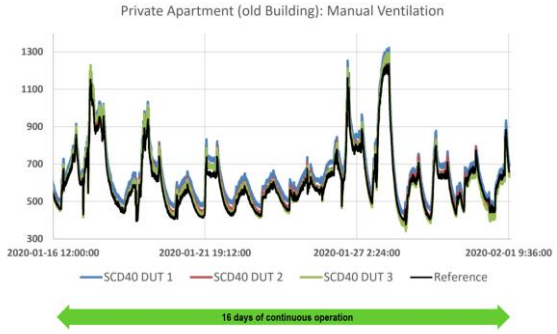


Field study with reference sensor

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



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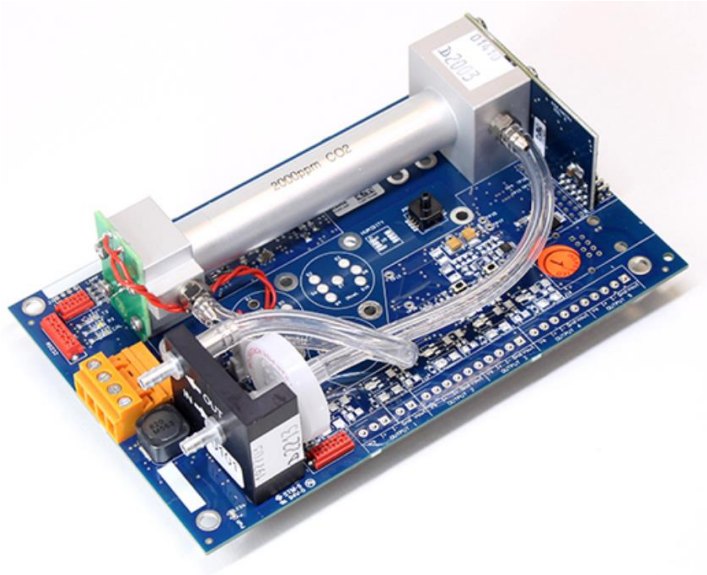
Recommended CO_2 Reference: Edinburgh Gascard NG 0 – 1%



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 referencere. Recommendation:
    - Edinburgh Gascard NG 0 – 1% & gas bottles with certified CO_2 concentration at 0 and 10000 ppm for recalibration.