Sensirion's SCD4x - Breaking the size barrier in CO2 sensing
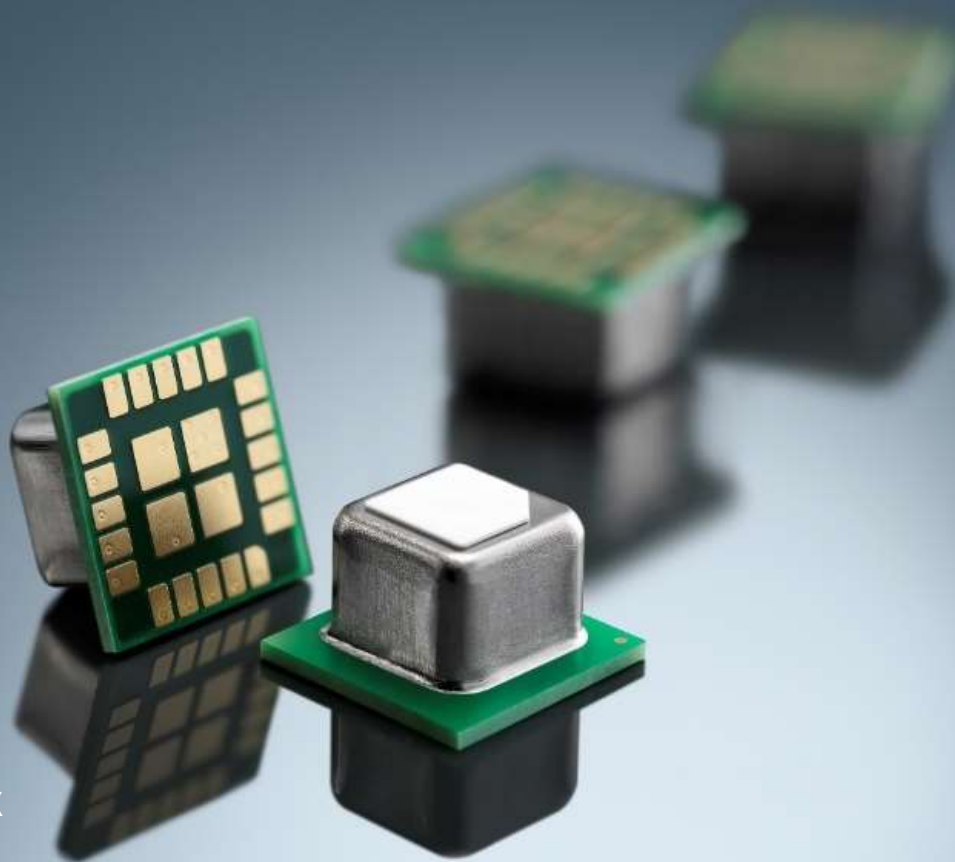
Marco Gysel
Product Manager CO2 Sensors at Sensirion

SENSIRION
THE SENSOR COMPANY

Breaking the size barrier for CO_2 sensing

Why measure CO_2?

Focus

- IAQ Monitoring Device
- Demand Controlled Ventilation
- Greenhouse
- Battery Management System
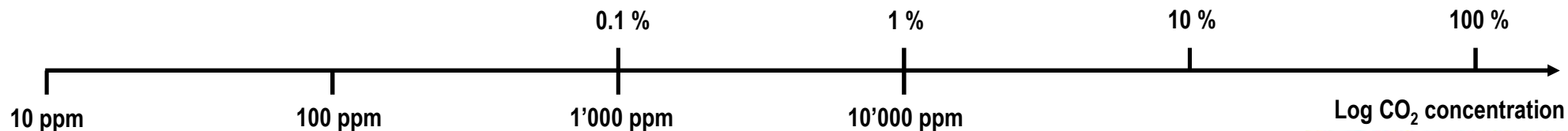- Grain Bin / Agricultural

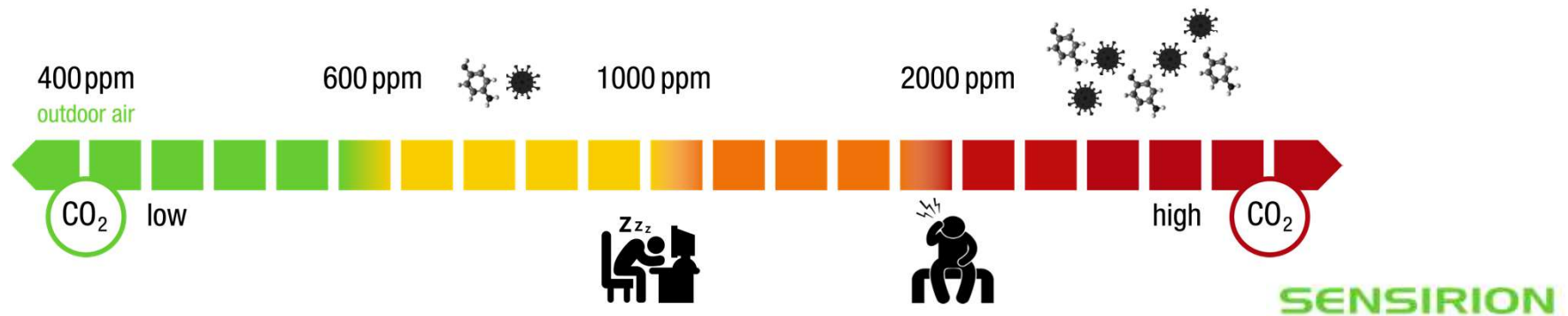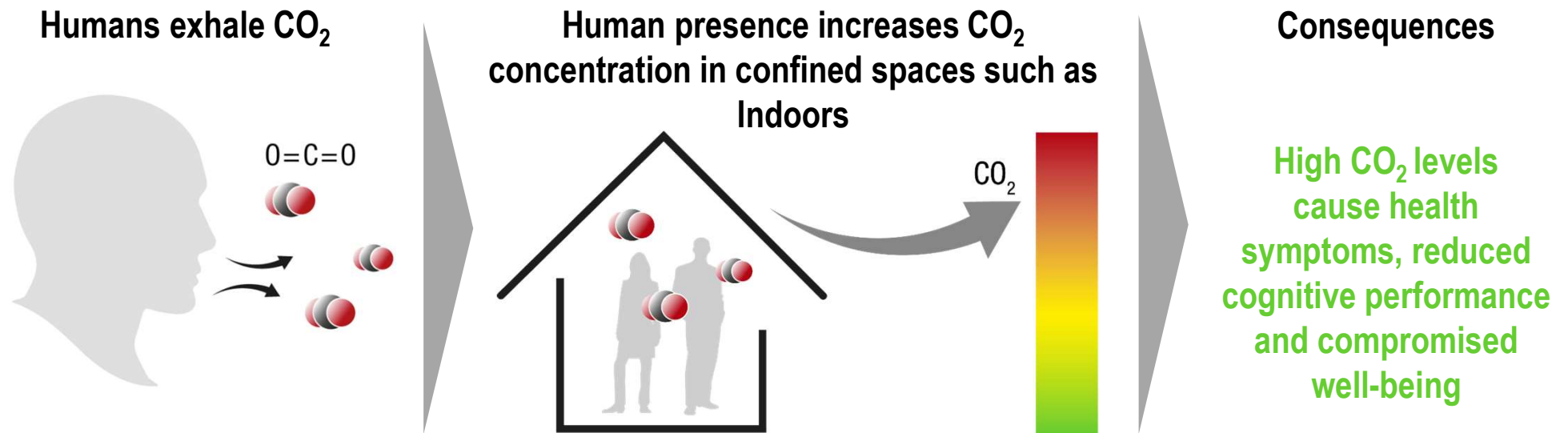- Industrial Safety / Leakage
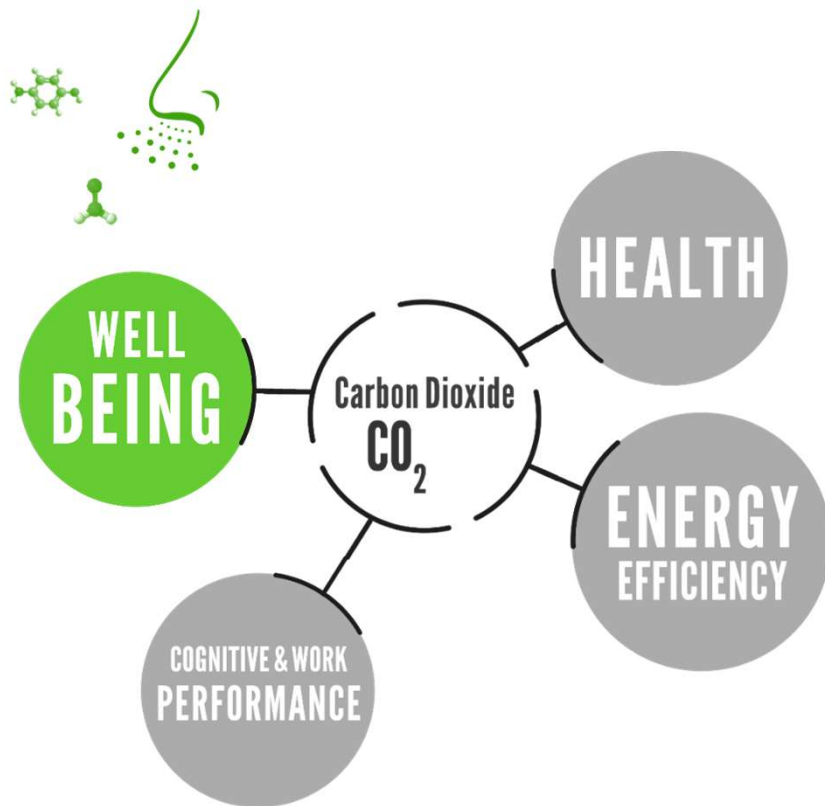- Incubator
- Fat Burning
- Food Storage / Cargo

STC31

SCD30 / SCD4x

| 0.1 % | 1 % | 10 % | 100 % |

| 10 ppm | 100 ppm | 1'000 ppm | 10'000 ppm | Log CO_2 concentration |

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Why measure CO_2? – Indoor Air Quality

Humans exhale CO_2

$O=C=O$

Human presence increases CO_2 concentration in confined spaces such as Indoors

CO_2

Consequences

High CO_2 levels cause health symptoms, reduced cognitive performance and compromised well-being

400 ppm
outdoor air

600 ppm

1000 ppm

2000 ppm

CO_2 low

high CO_2

SENSIRION

Sensing CO_2: Use-cases and applications

«80% of people are satisfied with perceived air quality when indoor CO_2 concentration is below 1000 ppm.»

$$PD = 395 \times e^{-15.15 \times CO_2(ppm(v))^{-0.25}}$$

SENSIRION

Sensing CO$_2$: Use-cases and applications
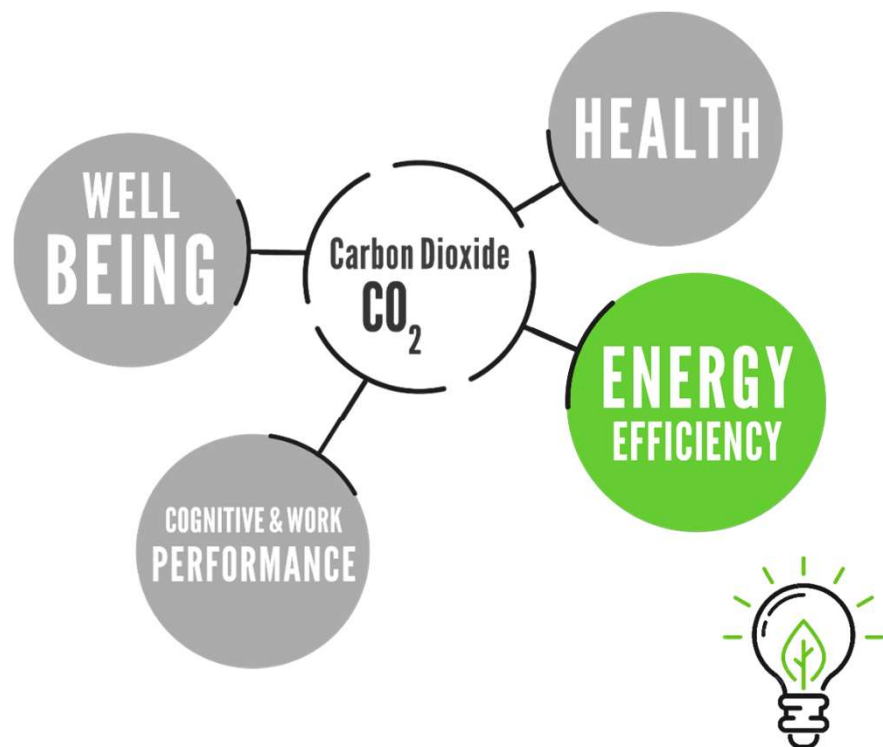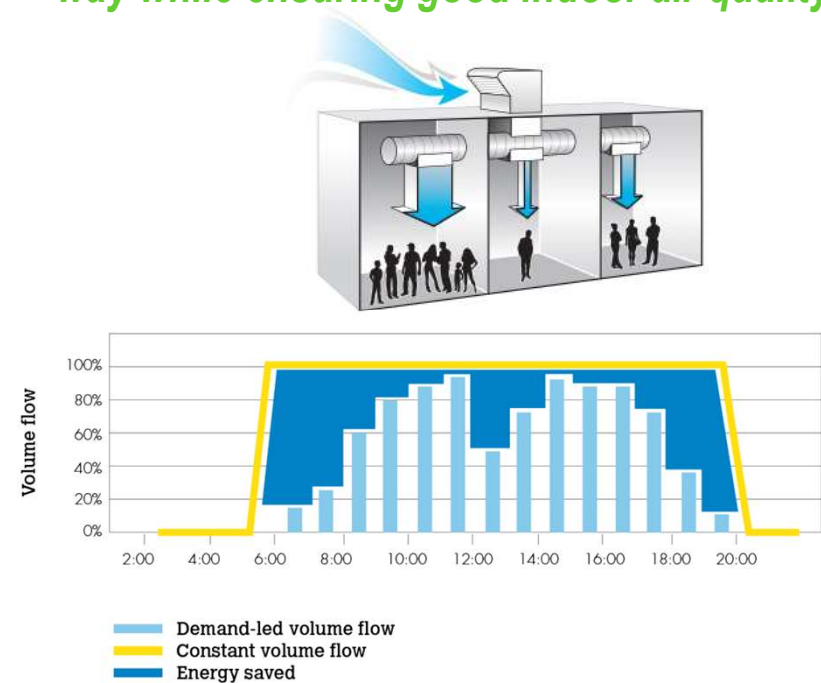

Source: Decision-making performance» , *Environmental Health Perspectives. 120 (12). doi:10.1289/ehp.1104789*

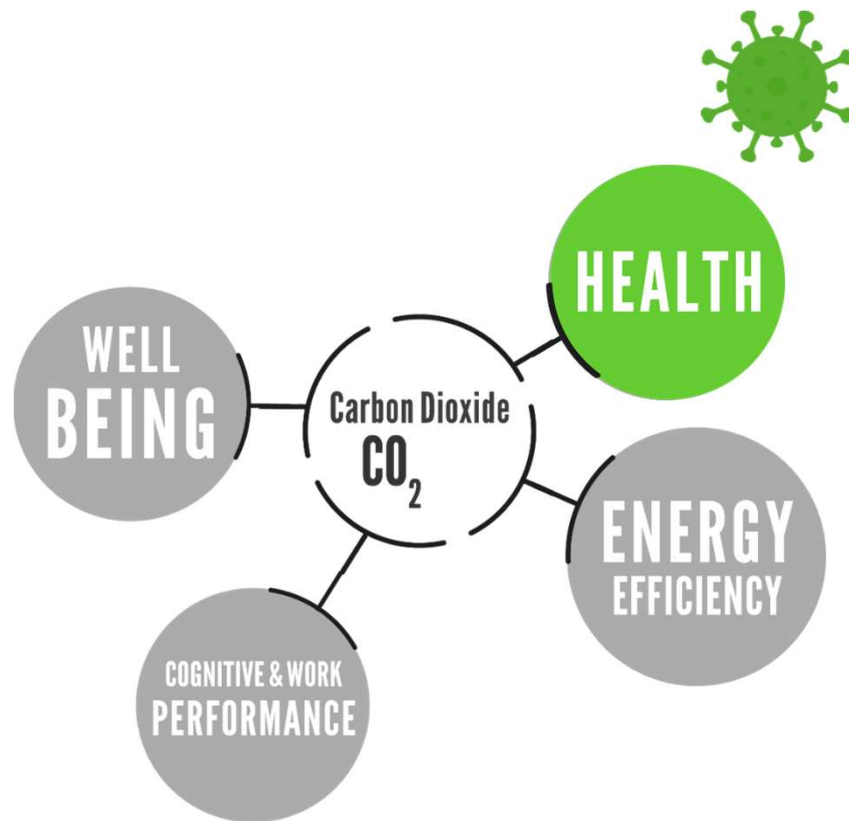# Sensing CO_2: Use-cases and applications

Demand-controlled ventilation (DCV): *"Usage of a CO_2 sensor to actively regulate building ventilation systems in the most energy-efficient way while ensuring good indoor air quality"*

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Sensing CO_2: Use-cases and applications

WELL BEING

Carbon Dioxide CO_2

HEALTH

ENERGY EFFICIENCY

COGNITIVE & WORK PERFORMANCE

OXFORD ACADEMIC

It Is Time to Address Airborne Transmission of Coronavirus Disease 2019 (COVID-19) FREE

Lidia Morawska ✉, Donald K Milton

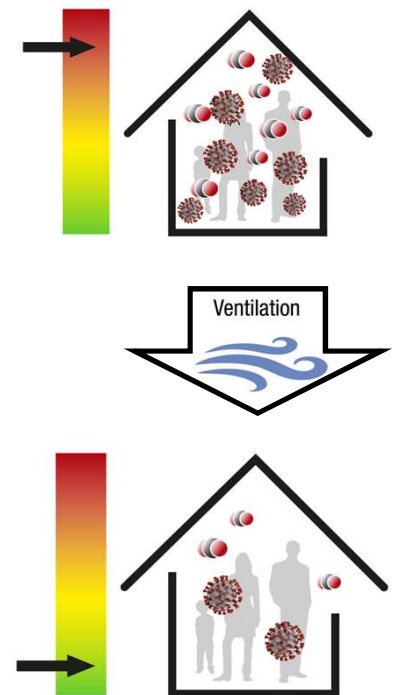*Clinical Infectious Diseases*, ciaa939, https://doi.org/10.1093/cid/ciaa939
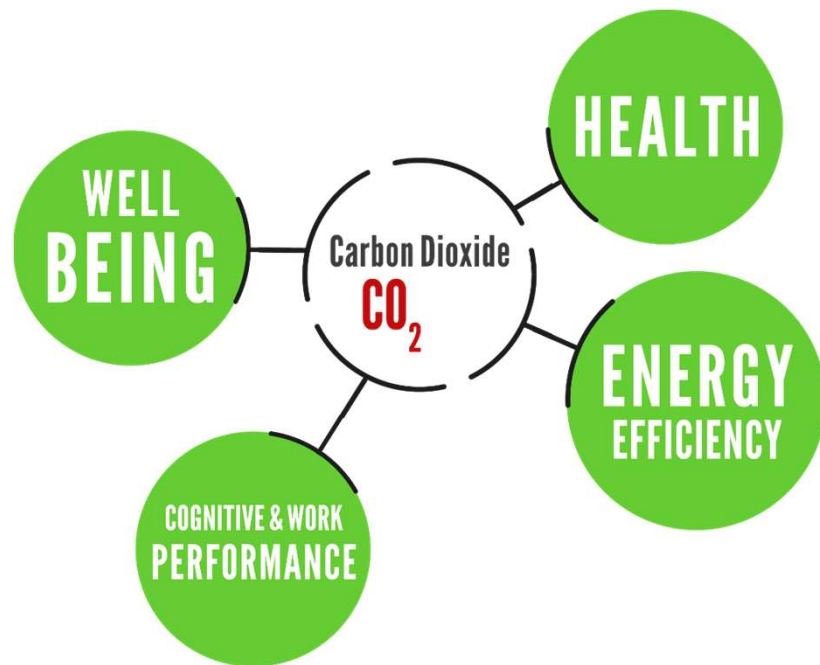Published: 06 July 2020   Article history ▾

[…]

"Provide sufficient and effective ventilation (supply clean outdoor air, minimize recirculating air) particularly in public buildings, workplace environments, schools, hospitals, and aged care homes."

[…]

Ventilation

SENSIRION

Sensing CO$_2$: Use-cases and applications

WELL BEING

Carbon Dioxide CO$_2$

HEALTH

ENERGY EFFICIENCY

COGNITIVE & WORK PERFORMANCE

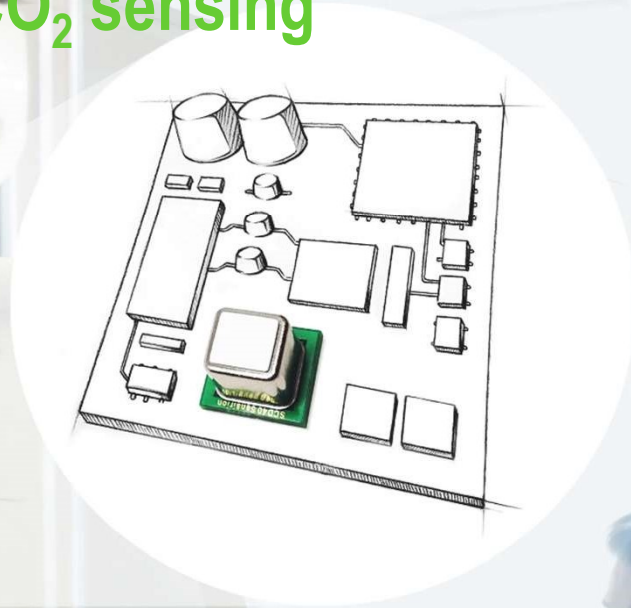HVAC / Demand-controlled ventilation

Indoor Air Quality Monitor

CO$_2$ Traffic Light Indicator

Air Treatment Devices / Appliances

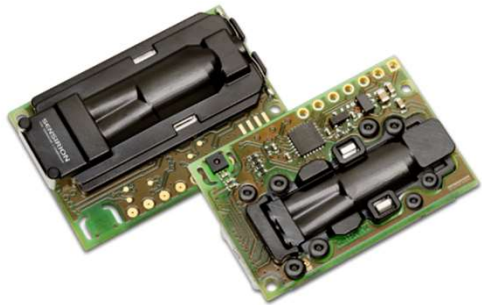Smart Home / Consumer Electronics

SENSIRION

SCD4x: Breaking the size barrier for CO$_2$ sensing

SCD4x how? - Before breaking the rules you must master them

SCD30 success story

- Dual channel NDIR CO_2 sensor

- Highest performance and superior long-term stability

- Integrated temperature and humidity sensor

- Thinnest package on the market

SCD4x miniature CO_2 sensor

- SCD4x mission: break the size and cost barrier to revolutionize the CO_2 sensing market to enable new use-cases

- SCD4x powered by novel photoacoustic sensing technology: PASens®

- Integrated temperature and humidity sensor

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SCD4x: a truly disruptive CO_2 sensor

SCD4x Features

Smallest CO_2 sensor: 10 x 10 x 7 mm^3

Up to 10 times smaller than other CO_2 sensors!

SENSIRION

SCD4x: a truly disruptive CO_2 sensor
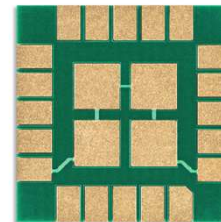
SCD4x Features

- Smallest CO_2 sensor

  SMD soldering, tape & reel package

  -> automated production, calibration and testing

- **Highly automated manufacturing**
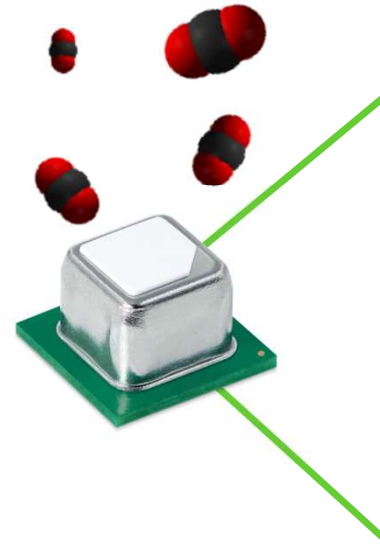- High reliability, no human errors
- **Small**, fits in every device

SENSIRION

SCD4x: a truly disruptive CO_2 sensor

SCD4x Features

- Smallest CO_2 sensor

- SMD soldering, tape & reel package

Great sensing performance

- Measurement range:
  0 ppm – 40'000 ppm

- Accuracy: $\pm$(40 ppm + 5%)

- Fully calibrated and linearized output

- **On-chip RH/T compensation**

- Digital I^2C interface

SENSIRION

SCD4x: a truly disruptive CO_2 sensor

SCD4x Features

- Smallest CO_2 sensor

- SMD soldering, tape & reel package

- Great sensing performance

Robust versus shock and mechanical stress

✓ Robust against shock, drop and stress

✓ Low number of components – less failure

✓ No failure modes of optical path

✓ **High robustness against dust and condensation.**

SENSIRION

SCD4x: a truly disruptive CO_2 sensor

SCD4x Features

- Smallest CO_2 sensor

- SMD soldering, tape & reel package

- Great sensing performance

- Robust versus shock and mechanical stress

Highest sensor versatility

- Large supply voltage range: **2.4 V – 5.5 V**

- Features **low power** mode and **single shot** mode

- Includes **RH and T** output signal

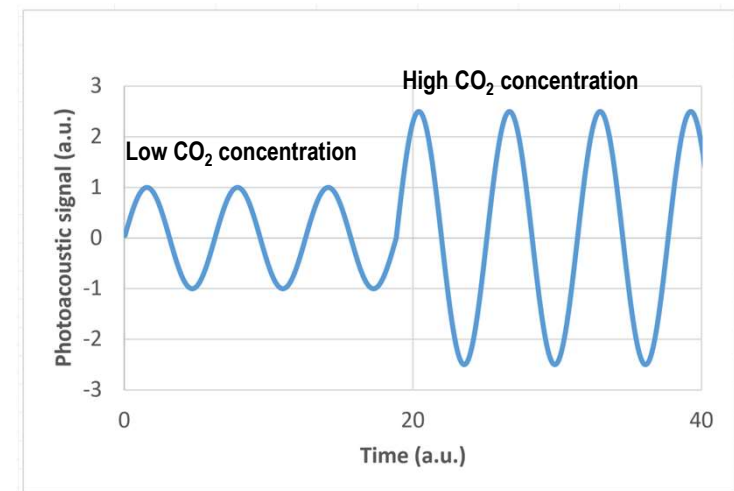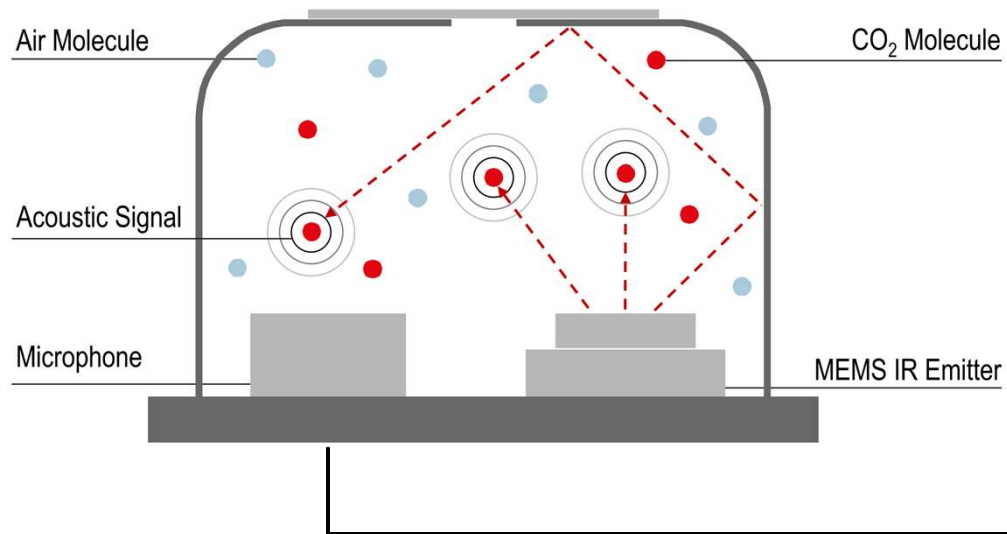**SENSIRION**

Product variants: SCD40 vs. SCD41

	SCD40	SCD41
	Product variant for cost sensitive markets	*Product variant for demanding applications & markets*
Accuracy	± (50 ppm + 5 % of reading)	± (40 ppm + 5 % of reading)
Specified output range	400 – 2'000 ppm	400 – 5'000 ppm
Output range	0 – 40'000 ppm	
Form / footprint / firmware	same	
Low power mode	Specified	Specified
Low power single shot mode	Not specified	Specified

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Photoacoustic sensing technology explained

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Photoacoustic sensing technology: how it works

SENSIRION

Photoacoustic sensing, a well-established technology

Applications of photoacoustic sensing techniques
Andrew C. Tam
Rev. Mod. Phys. **58**, 381 – Published 1 April 1986

- Photoacoustic sensing principle established for several decades
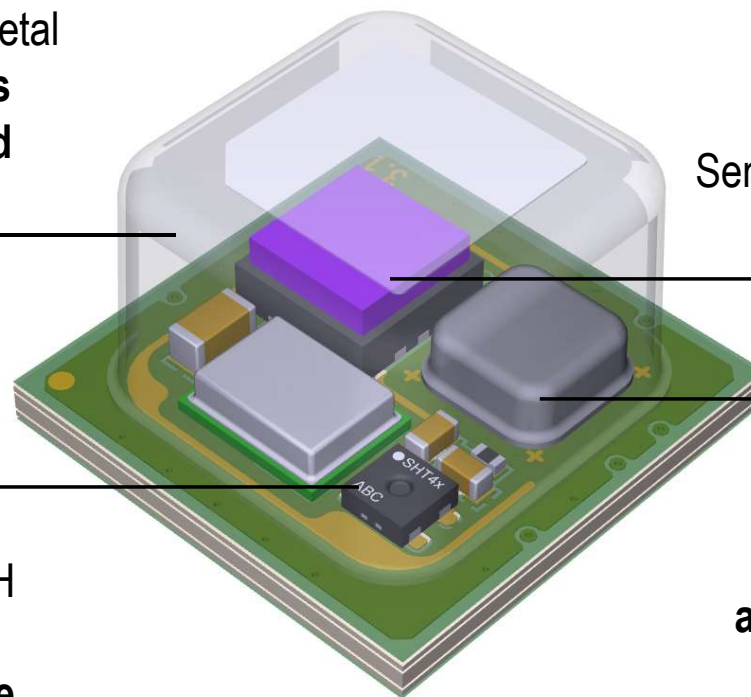- In the past reserved for expensive and bulky lab-scale instruments

- Sensirion's MEMS and packaging expertise enabled miniaturizing CO_2 sensors based on the photoacoustic sensing principle.
- Economy of scale and in-house key components

SENSIRION

PASens® technology – competitive edge through innovation

Component protection through metal cap ensures **highest robustness against dust, condensation and mechanical impact**

Sensirion MEMS IR emitter to realize **high long-term stability**

Sensirion humidity and temperature sensor - Superior RH and T compensation to **realize accurate readings across entire RH and T range**
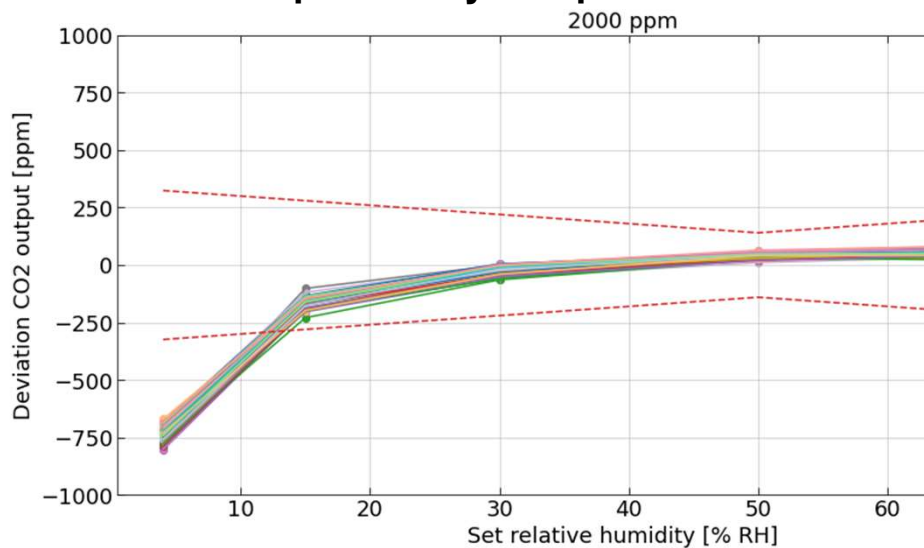
Dive-in next slide

Sensirion signal processor leverages advanced signal processing to ensure **highest accuracy and lowest noise level**

SENSIRION

SCD4x humidity compensation effectiveness

- The photoacoustic sensing technology has an intrinsic humidity dependence
- The SCD4x realizes superb accuracy across a large relative humidity range thanks to the build-in SHT40 and a on-chip compensation algorithm
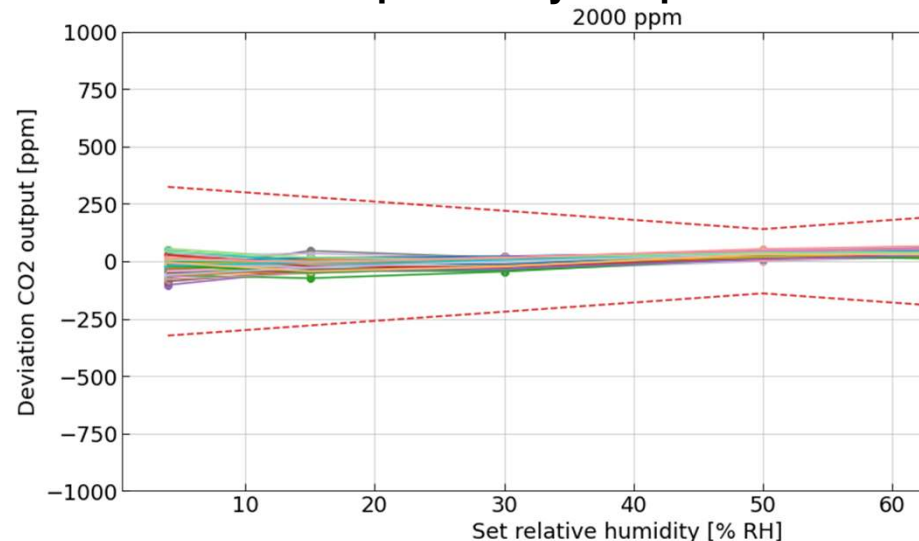
SCD4x accuracy @ 2000 ppm <u>without</u> on-chip humidity compensation

SCD4x accuracy @ 2000 ppm <u>with</u> on-chip humidity compensation
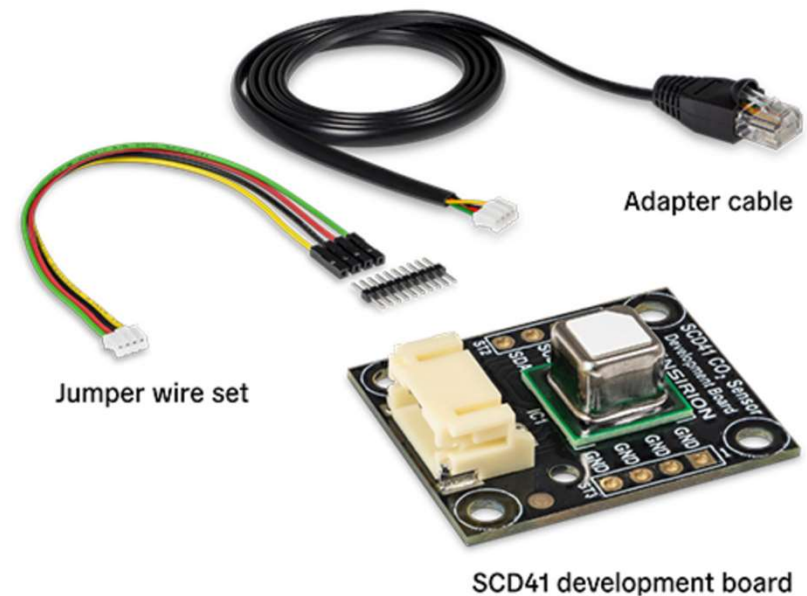
SENSIRION

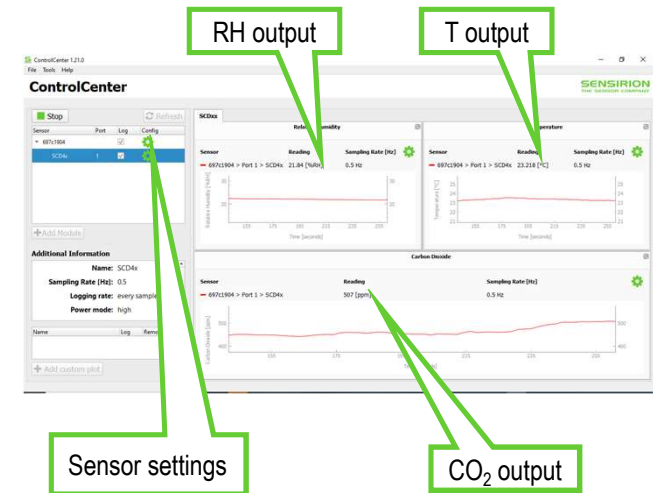Get ready for take off with the SCD4x

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How to get started: SEK-SCD41 (SCD4x Evaluation Kit)

"The SEK-SCD41 evaluation kit represents the perfect tool kit for effective SCD4x sensor evaluation and efficient prototyping."

Adapter cable

Jumper wire set

SCD41 development board

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Resources: www.sensirion.com/my-scd-ek

- Quick Start Guide Evaluation Kit

RH output

T output

Sensor settings

CO$_2$ output

SENSIRION

Resources: www.sensirion.com/my-scd-ek

- Quick Start Guide Evaluation Kit

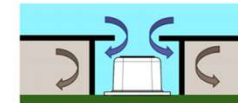- Documentation

Important Documents Evaluation Kit SEK-SCD41

- SEK-SCD41 Technical Description
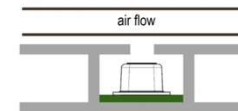- SEK-SCD41 STEP File

Important Documents SCD40 and SCD41

- Datasheet SCD4x
- SCD4x STEP File
- SCD4x Altium Footprint
- Handling Instructions
- Design-In Guideline
- Testing Guideline

Overview: The most important Design-in Recommendations

a.) Good coupling to ambient

d.) Decoupling from external heat sources

b.) Isolation from air turbulences

air flow

e.) Shielding from direct sunlight

c.) Decoupling from vibration sources

f.) Ensure stable supply voltage

SENSIRION

Resources: www.sensirion.com/my-scd-ek

- Quick Start Guide Evaluation Kit

- Documentation

- Drivers

Software and Drivers

- SCD4x Embedded Driver

- SCD4x Arduino Driver

- SCD4x RaspberryPi Driver

- Arduino Examples

- SCD4x Makecode for micro:bit

- SEK-ControlCenter Viewer Software

SENSIRION

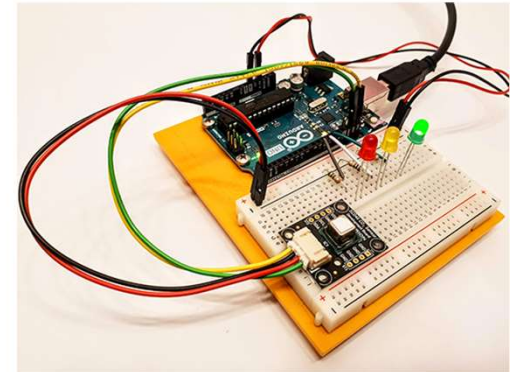# Resources: www.sensirion.com/my-scd-ek

- Quick Start Guide Evaluation Kit

- Documentation

- Drivers

- Tutorials

SCD41 Development Board Interfacing:

- Arduino

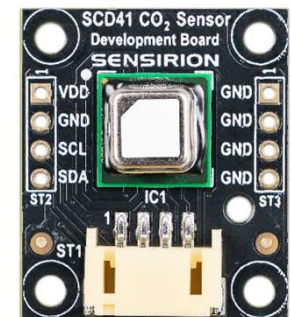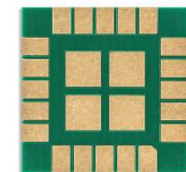- RaspberryPi

- Python Package

Use Case Tutorials:

- BLE Gadget for CO_2 Monitoring

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Summary

- CO_2 is a good proxy for indoor air quality. High CO_2 concentration compromises our well-being, cognitive performance and health.

- Sensirion's miniaturized SCD4x CO_2 based on the PASens® technology breaks the size barrier to enable wide-spread adaptation of CO_2 sensing.

- The SCD4x is available now! High volumes have been shipped to lead customers throughout 2021.

- The SEK-SCD41 evaluation kit enables easy sensor evaluation and prototyping. Documentation, drivers and tutorials: www.sensirion.com/my-scd-ek

Thank you for watching – Any questions?