

EBV SmartSensing&Control

amul OSRAM

Infineon

NXP

RENESAS

life.augmented

BROADCOM

MICROCHIP

onsemi

ScioSense

EBV IoT – Environmental Sensing



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Topics covered

- Ambient Air Quality – AAQ Legislation
- Applications & market analysis
- Theory of operation
- EBV portfolio
 - ams OSRAM
 - Broadcom
 - Infineon
 - NXP
 - Renesas
 - Sciosense
 - STMicroelectronics
- EBV-IoT – Demos and solutions
- Cloud Connectivity - IoTConnect



EBV  **SmartSensing&Control**

Ambient Air Quality – AAQ Legislation



Legislation of Ambient Air Quality (AAQ)

Ambient Air Quality (AAQ) Directives

Air quality in buildings on radar of European legislators (GEN - 1227.00)

European Parliament picks up on long-standing industry petition to regulate Indoor Air Quality

GEN - 1227.00. On 25 March 2021, the European Parliament adopted a resolution on the implementation of the Ambient Air Quality (AAQ) Directives, in which it calls on the European Commission to regulate Indoor Air Quality (IAQ) as well. The resolution is not binding on the Commission but is nevertheless a significant milestone in the efforts to enshrine IAQ into legislation. It confirms there is growing appreciation among legislators of the importance of clean air indoors, reflecting an ambition which Eurovent has been advocating for consistently.



Energy performance of buildings directive - EPBD

The directive will help reach the building and renovation goals set out in the European Green Deal



MAKING OUR HOMES AND BUILDINGS FIT FOR A GREENER FUTURE

Together with the proposals presented on 14 July, the revised Energy Performance of Buildings directive supports the development of **renewable and less polluting energy systems for our homes and public buildings**. They will:

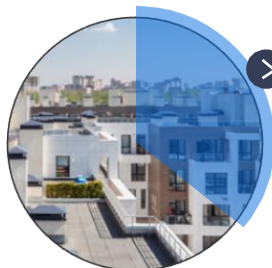
- decrease emissions
- save energy
- tackle energy poverty
- facilitate renovation
- improve quality of life
- generate jobs and growth



Buildings account for:



➤ **40%**
of energy
consumed



➤ **36%**
of energy-related
greenhouse gas
emissions



➤ **75%**
of EU buildings
are not energy
efficient



➤ **85-95%**
of EU buildings
are expected to
still be standing
in 2050



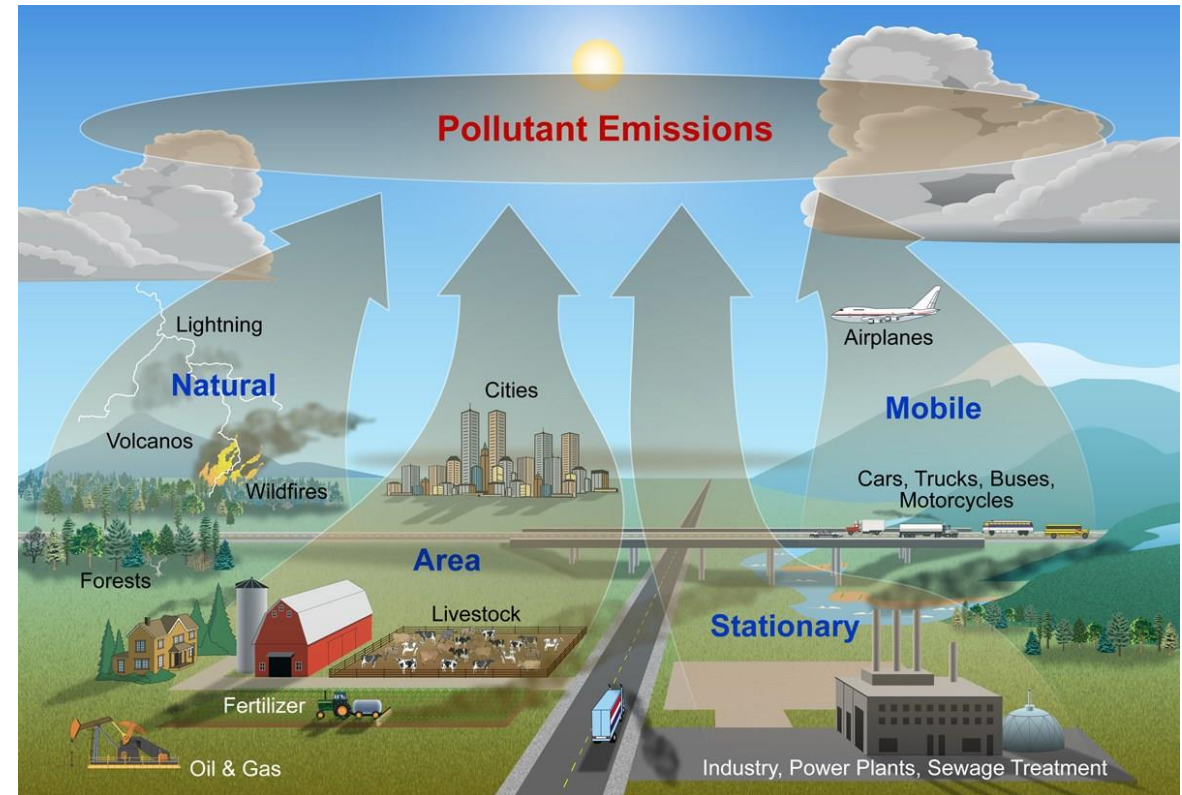
Ambient Air Quality – AAQ

What it is about?



Where Does Air Pollution Come From?

- **mobile sources** – such as cars, buses, planes, trucks, and trains
- **stationary sources** – such as power plants, oil refineries, industrial facilities, and factories
- **area sources** – such as agricultural areas, cities, and wood/oil/gas burning fireplaces
- **natural sources** – such as wind-blown dust, wildfires, and volcanoes



Sources of indoor air pollutants

Airborne particles

from diesel exhaust, dust, smoke, and other sources



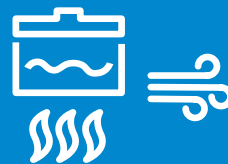
Indoor formaldehyde

from building materials, furniture, cooking, and smoking



Household odors&gases

from activities such as painting, cooking, and smoking



Ozone

from outdoor air (ground level ozone is harmful to breathe)



Carbon Dioxide

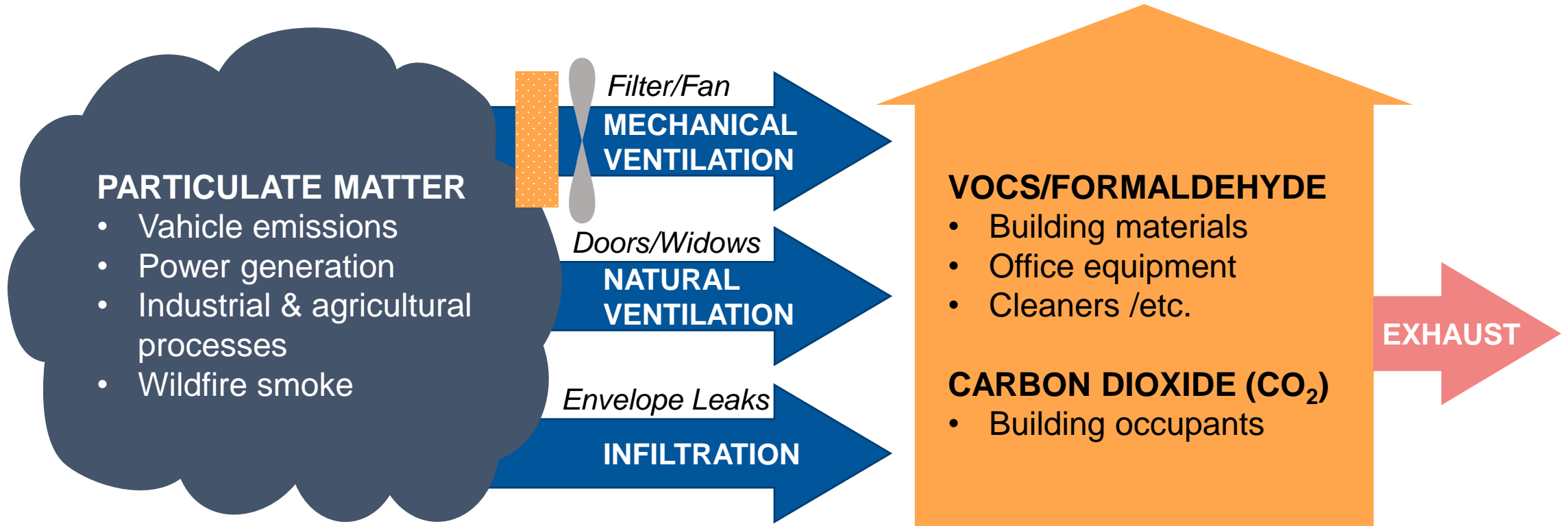
from people exhaling and cooking



Sources of indoor air pollutants

OUTDOOR POLLUTANT SOURCES

INDOOR POLLUTANT SOURCES



Why does CO₂ measurement matter?

Indoor air quality monitoring matters...



...for our comfort & well-being



...for health – reducing the risk of
virus transmission



...for demand controlled
ventilation & energy (cost) savings



Air Quality

TVOC CO₂ Humidity

Indoor Air Quality

Outdoor Air Quality

Ozone /
Nitrogen
Dioxide PM2.5

0 – 1 mg/m ³	400 - 1000 PPM	0% - 30%
1 – 3 mg/m ³	1000 – 2000 PPM	30% - 60%
3 – 10 mg/m ³	2000 – 5000 PPM	60% - 100%



0 – 100 ppb	0 – 35.4 ug/m ³
100 – 200 ppb	35.4 – 150.4 ug/m ³
200 – 500 ppb	150.4 – 500 ug/m ³



Source

RENESAS



Gas sensors: VOC, indoor Air quality

What are VOCs?

Volatile Organic Compounds (VOCs) are emitted as gases from certain solids or liquids.

Formaldehyde (one of them) can be found in **adhesives, floor polishes, glue, paint, cleaners...**
Benzene, Methylene chloride, Chlorofluocarbons ... are **some other VOCs.**

What is the effect of VOCs on human body?

Volatile Organic Compounds (VOCs) concentration may generate health issue (*can be up to serious issues if the exposure is regular or some VOCs high concentration*)

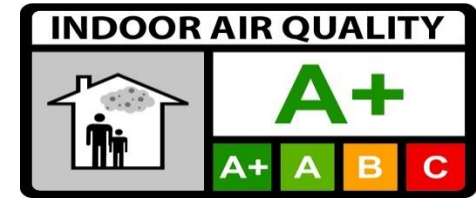


Source



Level	Category	TVOC Level	VOC Effects	CO ₂ Level above outdoor level	CO ₂ Effects
1	Fresh	<250ppb	No impact	400 – 1499 ppm	No impact on health or decision making
2	Moderate	250 – 449 ppb	Eye, Nose, Throat, Skin Irritation, Headaches, Nausea, Dizziness	1500 – 2499 ppm	Moderate Decision-Making Fatigue, Impairment and Concentration*
3	Poor	>450ppb	Long Term Exposure: Carcinogenic, Lungs, Liver, Kidney & Central Nervous System damage Eye, Nose, Throat, Skin Irritation, Headaches, Nausea, Dizziness	>2500 ppm	Health Effects >5000 ppm (Nausea, Headache, Dizziness). Significant Impairment of Performance & Decision-Making*

* Usha Satish et. al, Environmental Health Perspectives, Dec 2012



Jargon

Air Quality – CO₂, VOC and More

- **CO₂**
 - Has historically (Pettenkofer – see below) developed to the standard surrogate for air quality in confined spaces
 - Some HVAC standards (e.g. ASHRAE, USA) exclusively rely on CO₂
 - **Within the range used for ventilation control (≤ 2000 ppm), CO₂ has no impact on human health**
(see [slide CO₂ and Its Real Impact on Our Well-Being](#))
- **VOCs**
 - Volatile Organic Compounds = mixed gas = hydrocarbons (C_xH_y), and similar gases, often include CO and hydrogen
 - VOCs cause eye irritations, headache, dizziness and contribute to sick building syndrome (SBS)
 - **Besides humidity, VOCs are the most critical reason to ventilate**
- **Relation between CO₂, hydrogen and VOC**
 - Whenever humans produce CO₂, they also produce proportional amounts of hydrogen and vice versa
 - Odors from building material, carpets, furniture, cleaners, etc. are plain VOC-events
 - **Modern VOC-sensors detect both, harmful VOC-concentrations and unpleasant odors while capturing hydrogen**
- **Pettenkofer**
 - Max von Pettenkofer, German Chemist, 1818-1901
 - Discovered relationship between well-being and CO₂-concentrations in indoor air in the 19th century
 - **Laid foundation for use of CO₂ as indoor air surrogate (1.000ppm rule)**

Source



Typical Indoor Air Contaminants

Source



Indoor Air		Typical Substances		Cure
Contamination Source	Emission Source	VOCs	Others	
Human Being	Breath	Acetone, Ethanol, Isoprene		demand controlled ventilation
		CO ₂		
		Humidity		
	Skin respiration and transpiration	Nonanal, Decanal, α-Pinene		
		Humidity		
	Flatus	Hydrogen, Methane		
	Cosmetics	Limonene, Eucalyptol		
	Household Supplies	Alcohol, Esters, Limonene		
	Combustion (Engines, Appliances, Tobacco Smoke)	Carbon Monoxide		
		CO ₂		
		Humidity		
Building Material, Furniture, Office Equipment,	Paints, Adhesives, Solvents, Carpets	Formaldehyde, Alkanes, Alcohols, Carbonyls,		permanent, 5-10% ventilation
	PVC	Toluene, Xylene, Decane		
	Printers, Copiers, Computers	Benzene, Styrene, Phenole		



Classifying Air Quality I

CO₂-, or equivalent CO₂-based

Source



- Guide Value
 - CO₂* in ppm (historically established as indicator/surrogate), or
 - equivalent CO₂ in ppm (eCO₂)
- Today's **classification** (slightly varies by country, organization, or standard)

Output		Comment / Recommendation
eCO ₂ / CO ₂	Rating	
>1500	Bad	Heavily contaminated indoor air / Ventilation required
1000 - 1500	Mediocre	Contaminated indoor air / Ventilation recommended
800 - 1000	Fair	Optional ventilation
600 - 800	Good	Average
400 - 600	Excellent	Target

- Ultimate historical (good/bad) threshold: 1000ppm (Pettenkofer's law)

* Indicator, only. Within the concentration range used for ventilation (400-2.000 ppm), CO₂ is not harmful to human health.



Classifying Air Quality II

AQI's (Air Quality Indices)

Source



- AQI's vary in thresholds and composition of analytes (specific VOC mix, may also include ozone, NO₂, particles, CO₂, CO, dioxines, mercury, etc.)
- Guide Values – exemplified by UBA's* AQI
 - VOC mix (TVOC) i.e. blend of 50 VOCs with individual thresholds
 - Mercury
 - Dioxines
 - Nitrogen Dioxide
 - ...
 - Does not consider hydrogen
- UBA **classification**

AQI-UBA		TVOC		Hygienic Rating	Recommendation	Exposure Limit
#	Rating	mg/m ³	ppm			
5	Unhealthy	10 - 25	2.2 - 5.5	Situation not acceptable	Use only if unavoidable Intensified ventilation recommended	hours
4	Poor	3 - 10	0.65 - 2.2	Major objections	Intensified ventilation recommended Search for sources	<1 month
3	Moderate	1 - 3	0.22 - 0.65	Some objections	Increased ventilation recommended Search for sources	<12 months
2	Good	0.3 - 1	0.065 - 0.22	No relevant objections	Sufficient ventilation recommended	no limit
1	Excellent	<0.3	0 - 0.065	No objections	Target	no limit

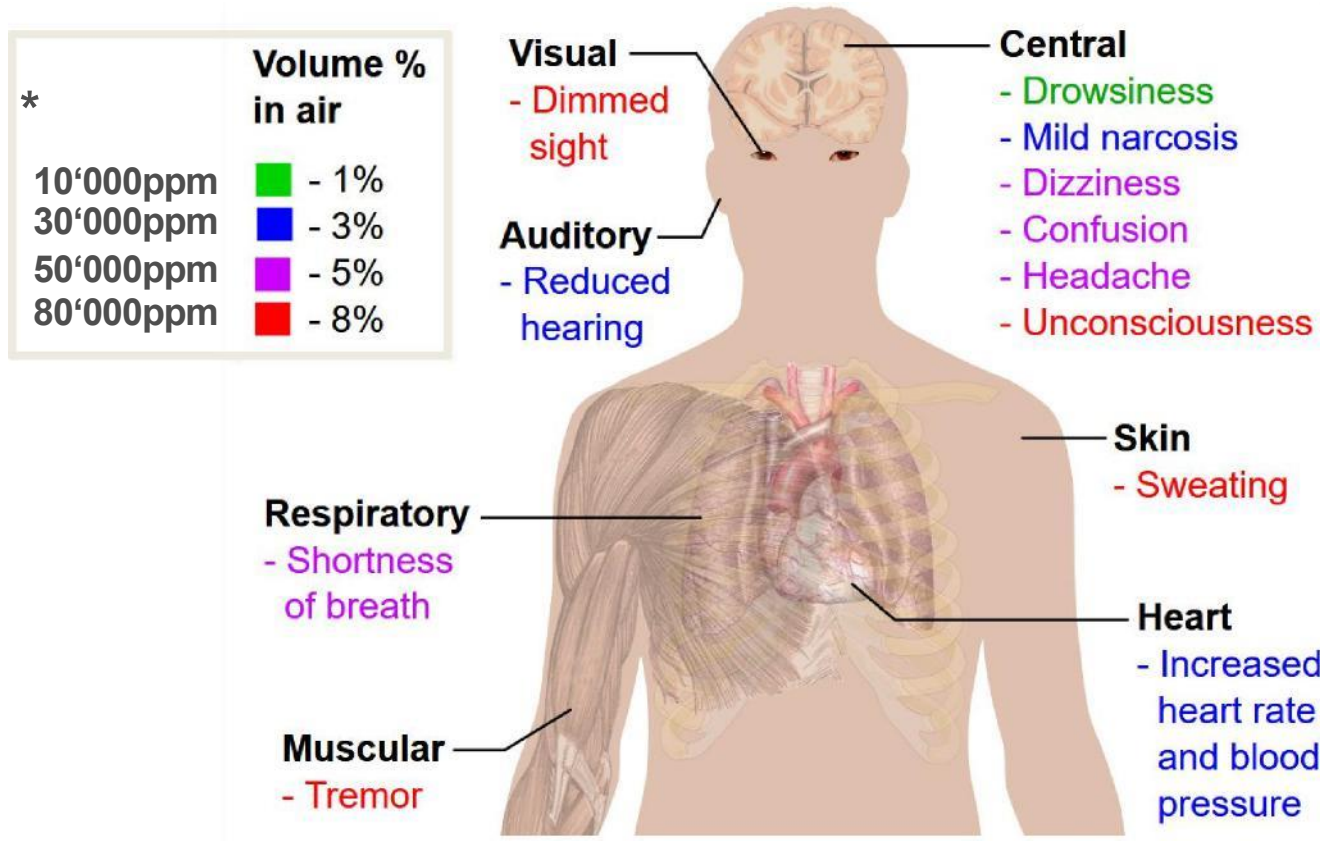


CO₂ and Its Real Impact on Our Well-Being

Source



WIKIPEDIA
The Free Encyclopedia



Important to know...

- Human breath contains approximately 4% (40,000ppm) of CO₂.
- Some people are permanently exposed to high CO₂ levels
 - 8,000ppm (standard for submarines)
 - 5,000ppm (ISS – International Space Station)
- The ASHRAE regulation is still based on CO₂

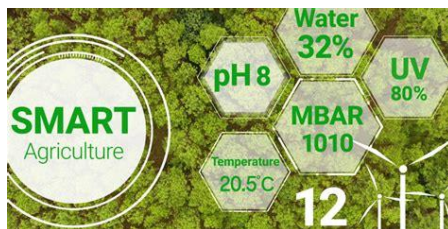
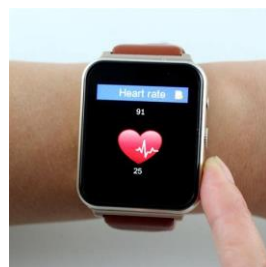
* Note: HVAC systems control between 0-2.000ppm CO₂. Within this range CO₂ is not harmful to human health.



Applications & market analysis



Temperature & Humidity - Applications



Temperature & Humidity - Market

TABLE 3 INDUSTRIAL SENSORS MARKET, BY SENSOR, 2017-2025 (USD MILLION)

Sensor	2017	2018	2019	2020	2021	2023	2025	CAGR (2020-2025)
Flow Sensor	2,353	2,497	3,145	2,813	2,964	3,483	4,447	9.6%
Temperature Sensor	2,730	2,859	3,552	3,134	3,256	3,718	4,607	8.0%
Level Sensor	3,155	3,336	4,186	3,730	3,916	4,567	5,786	9.2%
Gas Sensor	362	379	471	415	431	491	608	7.9%
Pressure Sensor	1,684	1,772	2,213	1,963	2,051	2,368	2,969	8.6%
Position Sensor	1,795	1,904	2,396	2,141	2,254	2,645	3,372	9.5%
Image Sensor	578	662	895	855	959	1,265	1,793	15.9%
Humidity and Moisture Sensor	1,007	1,122	1,482	1,388	1,527	1,950	2,689	14.1%
Force Sensor	1,418	1,510	1,908	1,713	1,810	2,142	2,753	10.0%
Total	15,083	16,042	20,248	18,152	19,168	22,628	29,024	9.8%

Source: Press Releases, Investor Relation Presentations, Annual Reports, Expert Interviews, and MarketsandMarkets Analysis

TABLE 1 AVERAGE SELLING PRICE OF VARIOUS INDUSTRIAL SENSORS, 2019

OFFERING	2019 (USD)
Flow Sensors	1.1
Temperature Sensors	0.7
Level Sensors	62.4
Gas sensors	21.1
Pressure sensors	0.9
Position Sensors	2.8
Image Sensors	1.1
Humidity and Moisture Sensors	0.893
Force Sensors	0.901

Source: Secondary Research, Expert Interviews, and MarketsandMarkets Analysis

The average selling price of industrial sensors varies from sensor to sensor.

Source

RENESAS



Smoke sensor market: 8.2% growth expected*

**Global
market**

3.4 Billion USD
(expected for 2027)



2.3 Billion USD
(in 2022)

Growth drivers:

- new achievements in advanced smoke detection e.g.:
 - False alarm suppression
 - Smart detectors:
 - Self testing
 - Connectivity for alerts and remote management
- Dual Sensor solutions with highest growth expectation
- rising governmental initiatives
- Servicing business cases for commercial buildings
- Europe will lead market
- Photoelectric sensors

*Source: e.g. [Smoke Detector Market Size, Share, Industry Forecast 2022-2027 \(marketsandmarkets.com\)](https://marketsandmarkets.com)



Trends for Smoke and Fire Detection

residential
homes

Facts:

- More false alarms (6%) cause fire service calls than real fires (5%)
- 1/3 of fires are related to buildings
(Source [CTIF 2018 n°23](#))

Regulation, Norms & Trend Update:

- Residential Homes: DIN 14676-1:2018-12 (<https://dx.doi.org/10.31030/2893226>)
 - **Remote inspection** (automated) possible now (DIN 14676-1C)
 - **IoT & connectivity!**
 - automated obstruction sensing possible by **ToF or Radar**
 - Multisensors now permitted (if **primarily for smoke detection**)
e.g. for **open kitchen** / combined kitchen & living room
- Smoke sensor norm EN54 part 7 and 29
 - Definition of **various smoke types** for testing → also against false alarm!
- “Burger-Test” = Smoke Alarm Nuisance Sources from Cooking Scenarios
- Smoke type info to help fight fire and to help curing injured people
- Queensland (Australia) enforced interconnected smoke detectors (-> connectivity)

Smoke sensors

→ for residential homes

In **non-domestic** buildings
more complex fire alarm systems may
consist of **Smoke, Fire Gas (CO), Flame,**
or **Heat Detectors**

non-domestic
& challenging residential rooms



amul OSRAM

BROADCOM
connecting everything

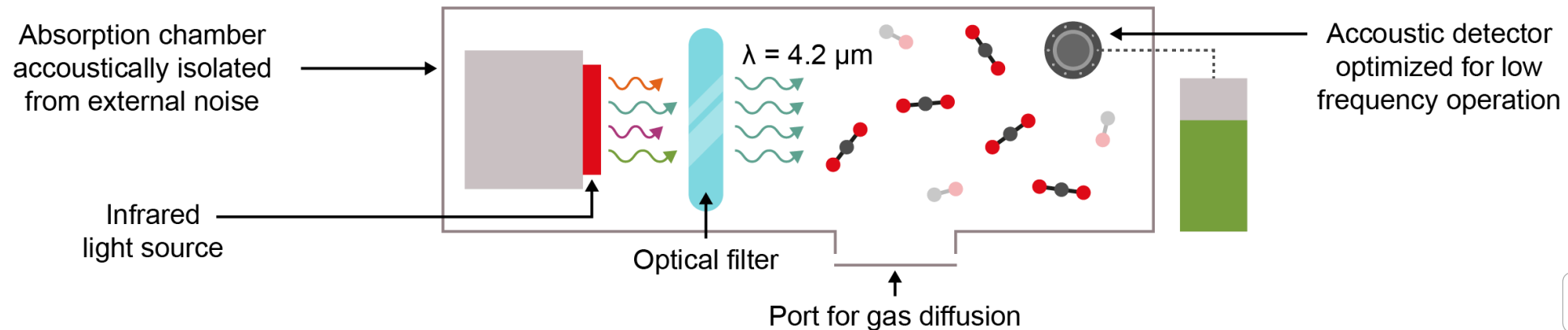


Theory of operation



PAS – Photoacoustic Spectroscopy principle for CO₂ detection

PAS – Photoacoustic Spectroscopy principle for CO₂ detection



Source



Principle

- › Infrared emitter with blackbody radiation characteristic – periodically chopped
- › Optical filter to filter wavelength related to specific gas ($\lambda = 4.2 \mu\text{m}$ for CO₂)
- › Low frequency acoustic detector acting as a pressure sensor
 - CO₂ molecules absorb light
 - Absorption causes a periodic local change of temperature and pressure
 - Change in pressure detected by the acoustic detector

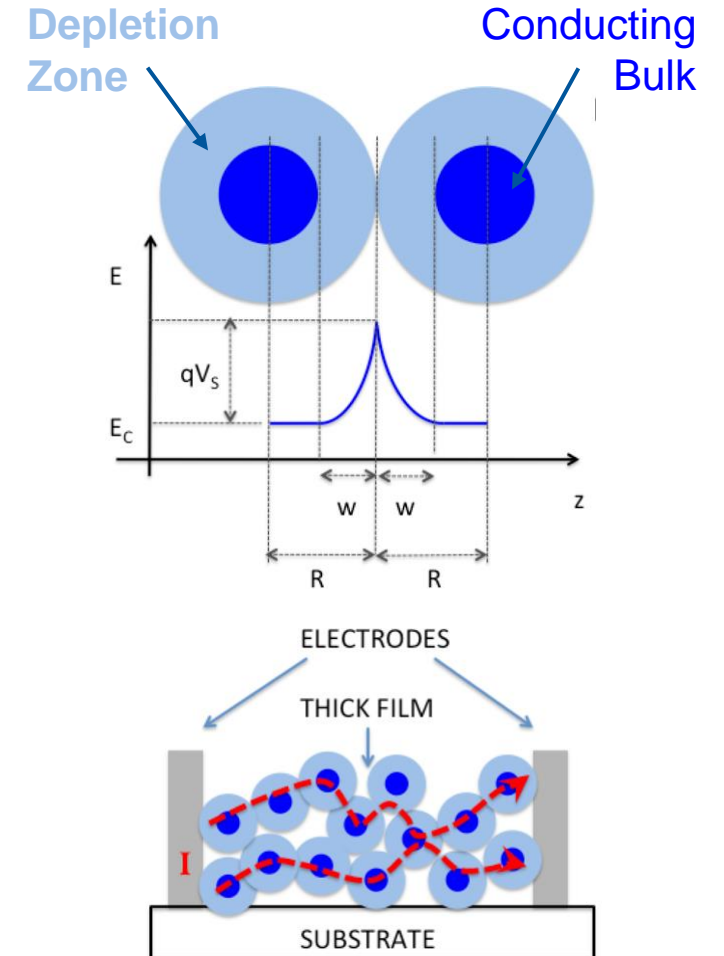
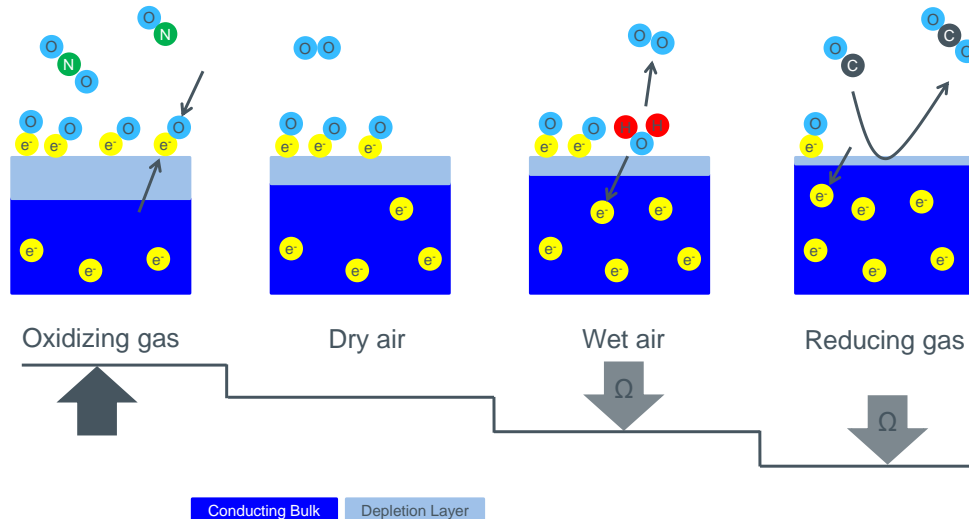
Detector

- › The absorption chamber is acoustically isolated from the external environment to provide accurate CO₂ sensing information, otherwise the function of CO₂ would be significantly disrupted
- › The detector is optimized for the low frequency range outside of the most important frequencies for speech and language



MOX Semiconductor – General principle

- A granular semiconducting material (SnO_2) is applied onto an electrode structure. This material can be doped with a catalyst to enhance performance.
- Typical temp. range is 200 to 400°C
- Oxygen from ambient air is absorbed onto the particles, trapping electrons
- A depletion zone is built
- A current is running through the layer on distinct paths
- The presence of oxidizing or reducing gases modulate the depth of the depletion zone
- The measured resistance is a function of gas concentration



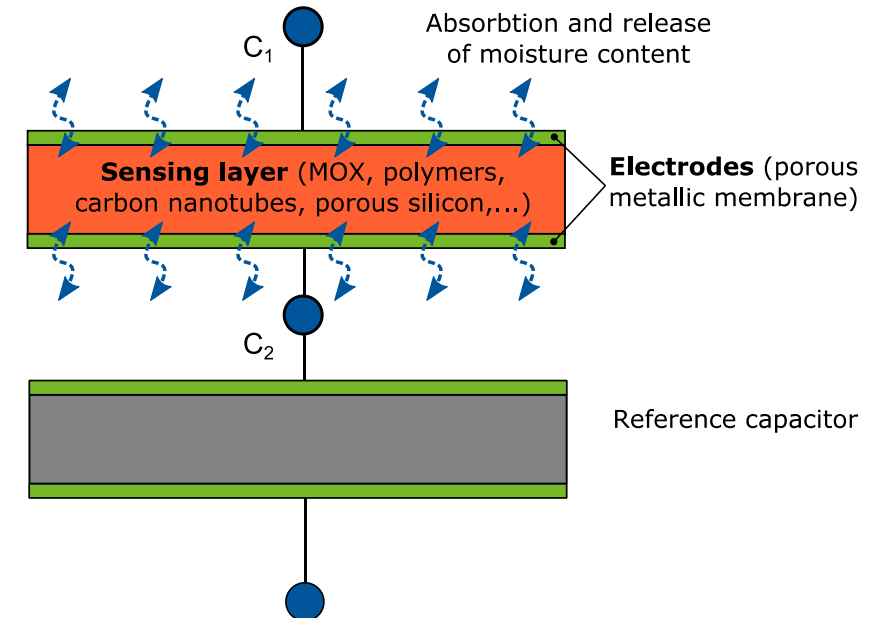
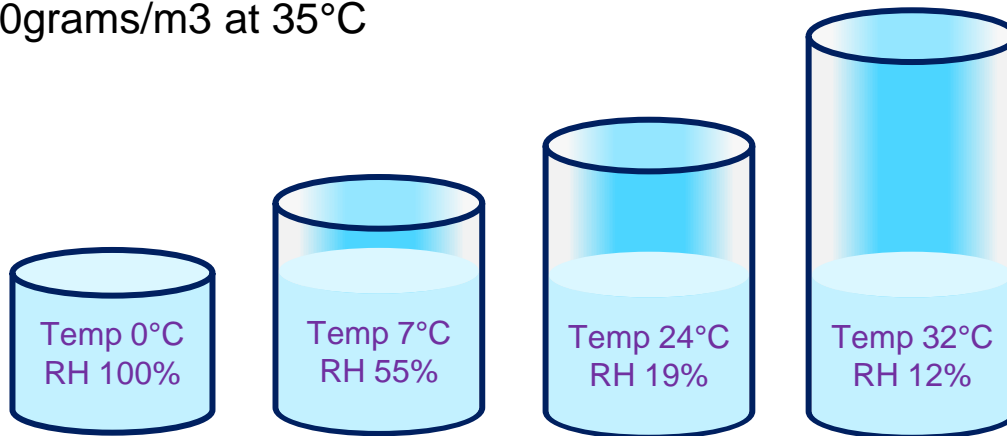
Source

SciSense®



Relative humidity

- RH is the ratio between the amount of water vapor (moisture) in the air at a given temperature to the maximum amount of water vapor the air can hold at that temperature; expressed in %
- RH is relative to the temperature at that moment
- Warm temperature can hold more moisture than cold temperature
- Dew Point is a better indicator for “how comfortable the air feels”, it is equal to or lower than ambient temperature
- Absolute Humidity is independent of temperature, 30grams/m³ at 35°C



- MOX: high sensitivity, long response time, large hysteresis
- Polyamide: high linearity, low sensitivity, fast response, almost no hysteresis



Key Technical issues

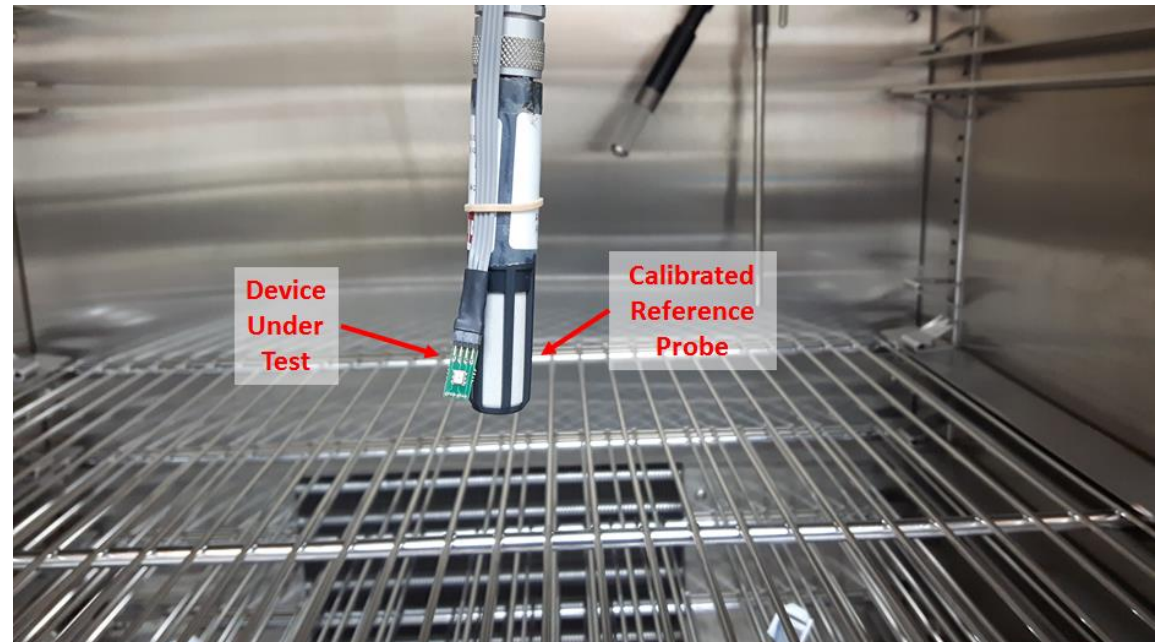
Checking very high %RH ACCURACIES is not straightforward

CHALLENGES:

- Humidity and temperature are **very slow** to stabilize (if at all !!)
- Major challenge to control **gradient** of the stimuli in an enclosed space
- **Humidity readings highly depends on temperature.** Thus, any fluctuations in temperature will throw off the humidity accuracy

SOLUTIONS:

- Must use a **professional** high-quality environmental **chamber**
- Must use a very **high-accuracy probe** inside the chamber – can not rely on chamber set point and control system
- Place the **sensor** under test as **close** as possible to the high-accuracy **probe** inside the chamber, as show in the figure
- If the chamber has a fan, place the device-under-test as far **away** as possible **from the fan**



Key Technical issues

All humidity sensors are fragile !

10. Soldering Information

- The recommended soldering profile for a lead-free (RoHS-compliant) process must be followed, to **avoid irreversibly damaging the sensor**.

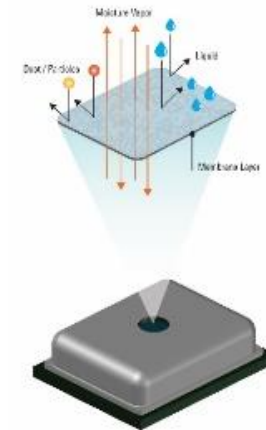
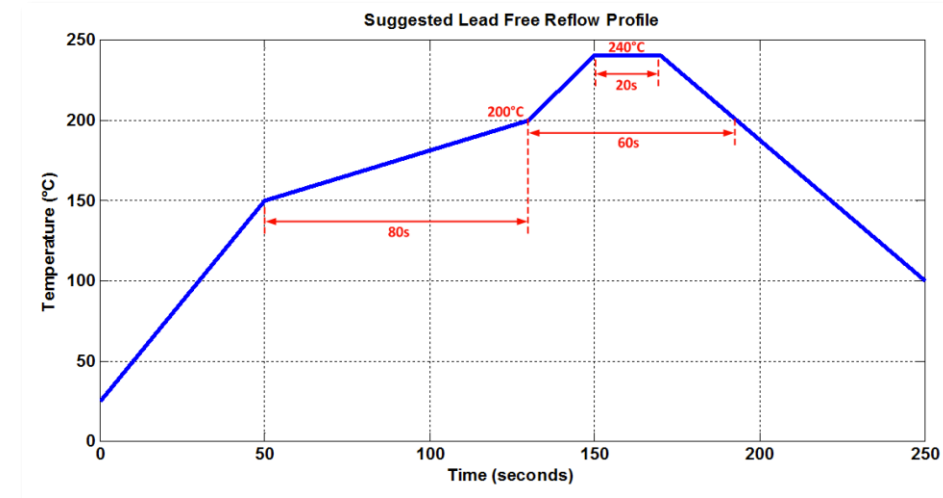
It is important to ensure this temperature profile is measured at the sensor itself. Measuring the profile at a larger component with a higher thermal mass means the temperature at the small sensor will be higher than expected.

- For manual soldering, the contact time must be limited to **5 seconds** with a maximum iron temperature of **350°C**.

==> In either case, a **board wash** after soldering is **not recommended**. Therefore, if a solder paste is used, it is strongly recommended that a **“no-clean” solder paste** is used to **avoid the need to wash the PCB**.

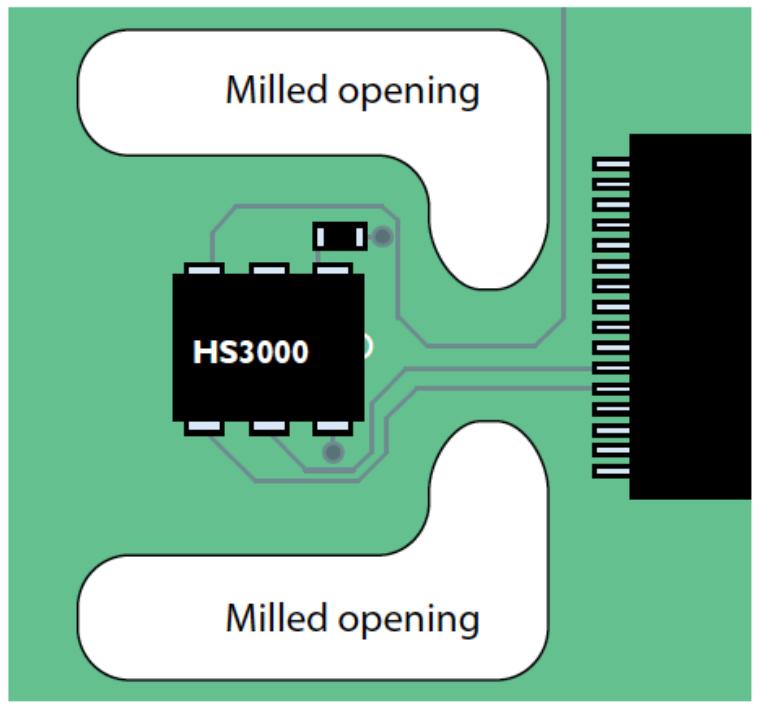
- The sensors tends to dry out, and must be rehydrated after the soldering process.
 - A relative humidity of 75% RH at room temperature for at least 12 hours
 - A relative humidity of 40% to 50% RH at room temperature for 3 to 5 days

Otherwise, in the relative humidity readings, there might be an initial offset, which will slowly disappear as the sensor is exposed to ambient conditions.



Key Technical issues

Layout to minimize heat transfer



Undesired heat transfer paths to the HS3000 chip must be minimized.

Stray/parasitic heat from other components on the PCB will result in inaccurate temperature and relative humidity measurements.

Solid metal planes for power supplies **should be avoided** in the vicinity of the sensor since these will act as thermal conductors.

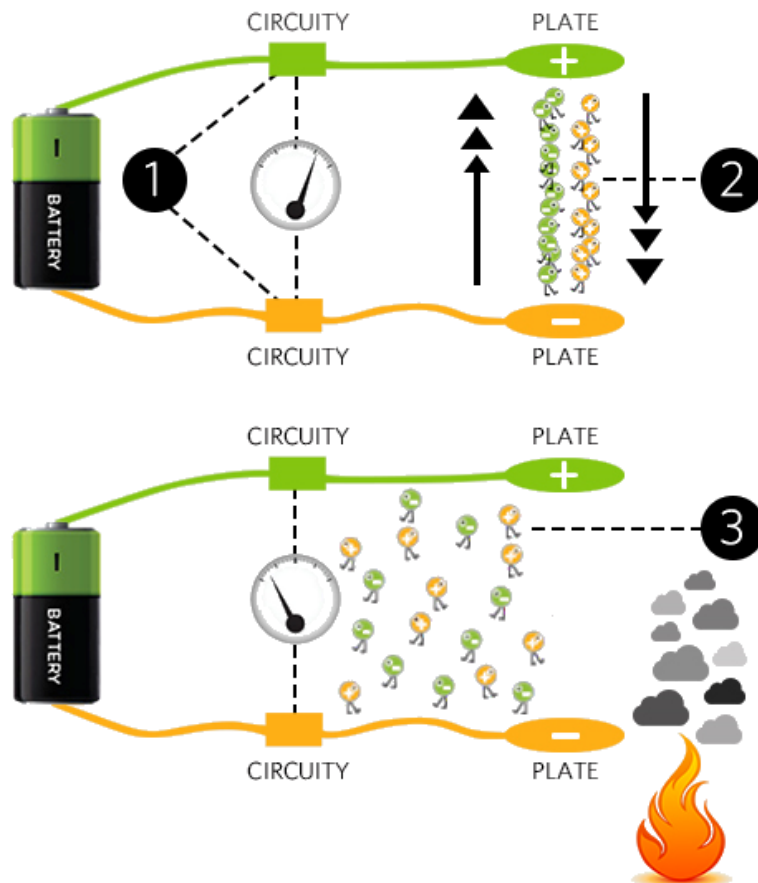
To further reduce the heat transfer from other components on the board, **openings can be milled into the PCB** as shown.



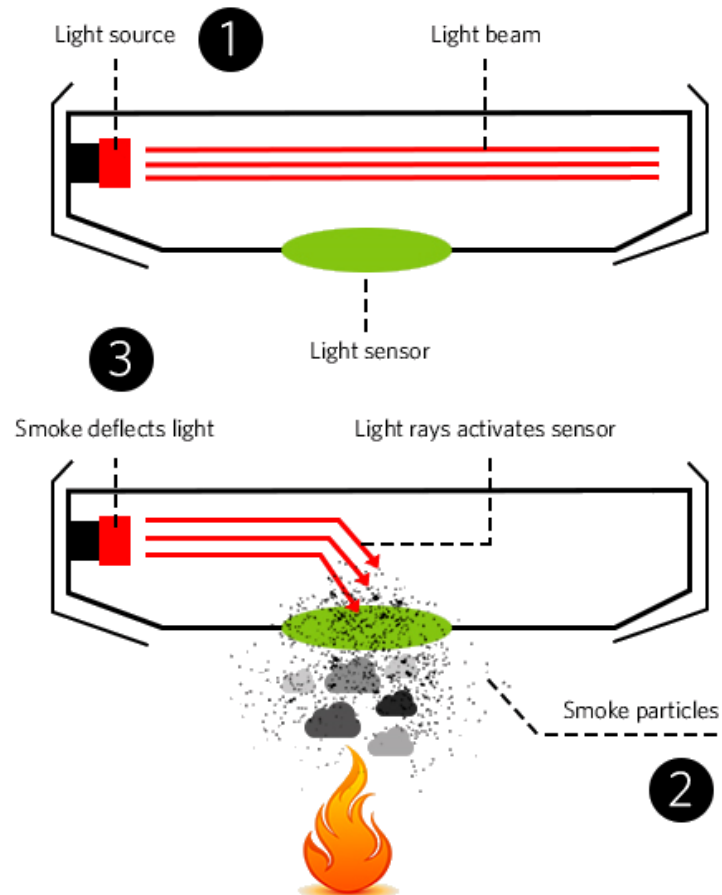
Fire/Smoke detection

Ionization vs. photoelectric

Ionization smoke alarm



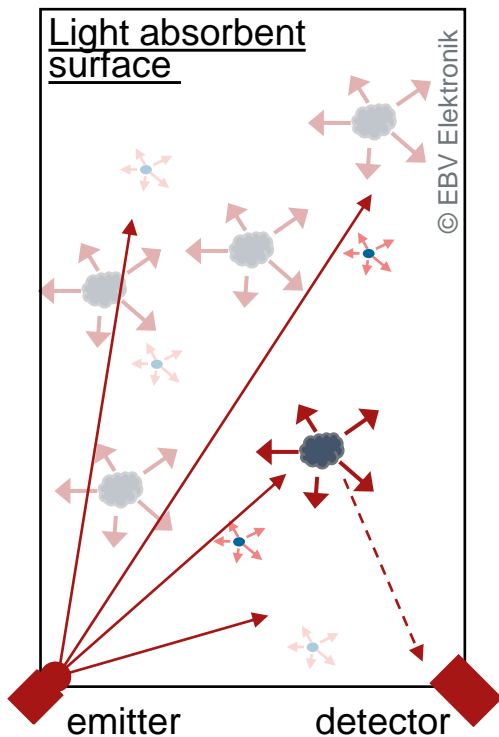
Photoelectric smoke alarm



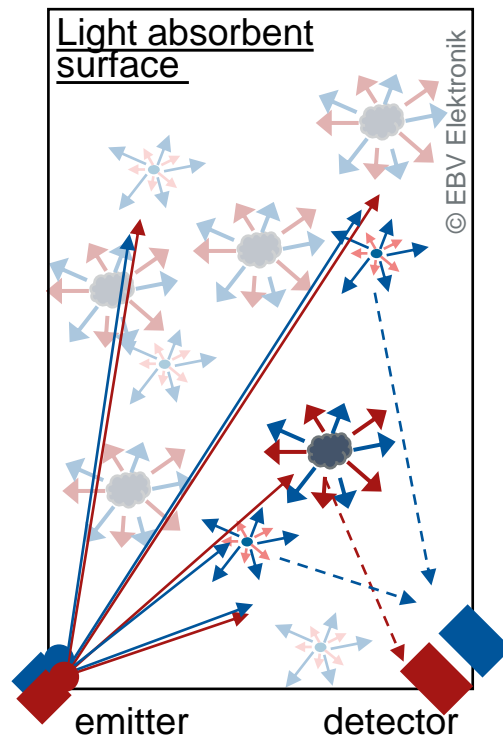
Fire/Smoke detection - Optical

Addressing false alarm challenges

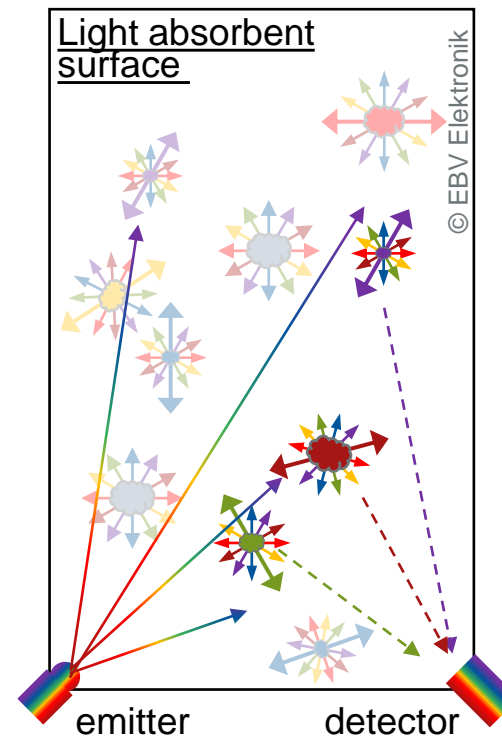
Basic smoke detector (IR only)



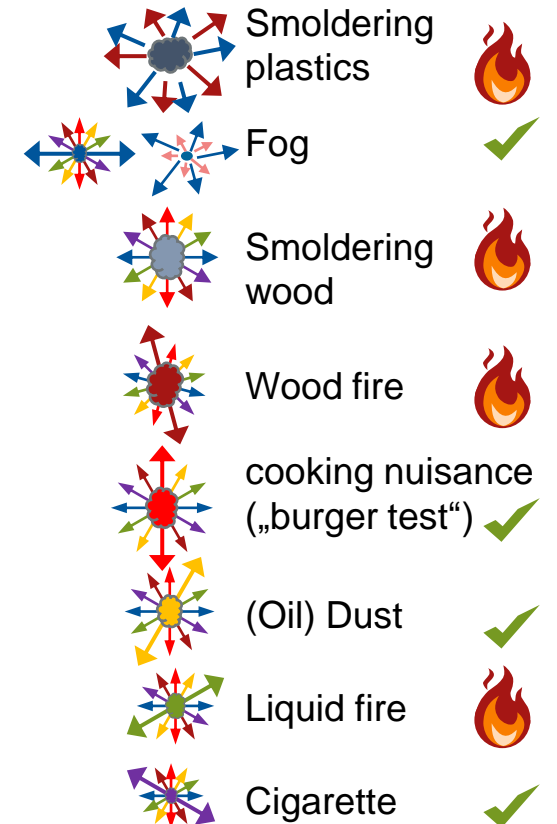
Advanced smoke detector (IR + blue)



Next generation: Multi-spectral smoke type classification



Spectral fingerprint → to decide on alarm



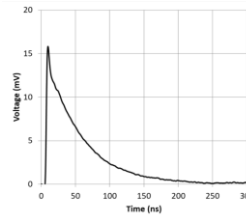
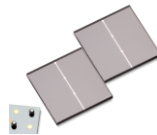
Radiation detection with SiPMs (Silicon photo multipliers)

Radiation (e.g. gamma)

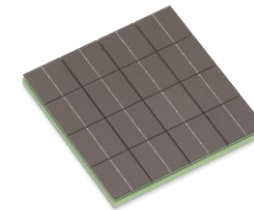


digital signal

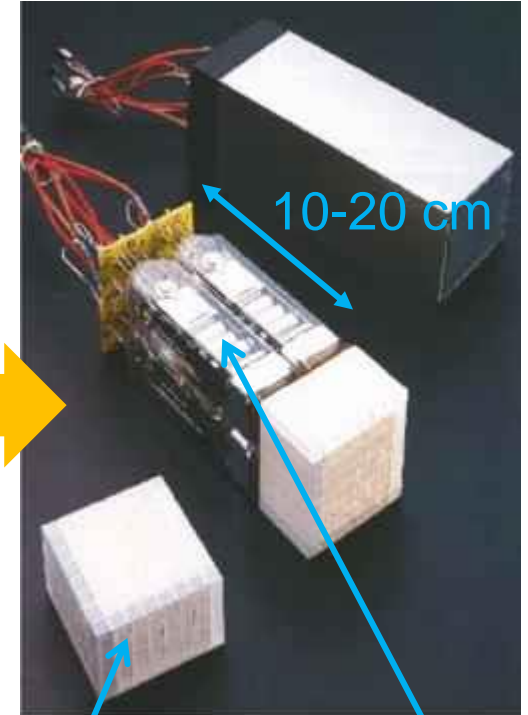
Radiation → Scintillation (light flash) → Light detection (PMT, SiPM,) → signal



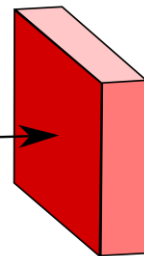
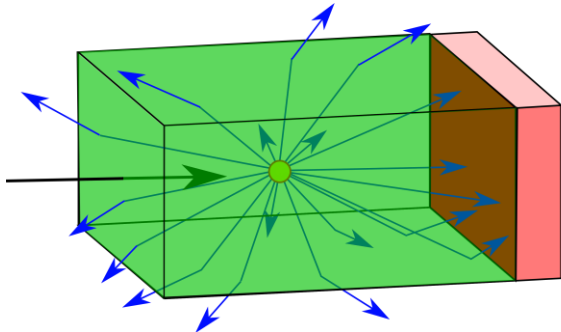
PN: AFBR-S4xx



SiPM thickness:
few mm!



Photomultiplier
Tube (PMT)



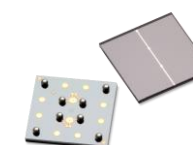
Energy (photon counting)

Time

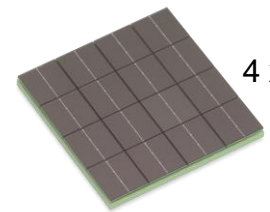
Applications

- Radiation detectors (based on scintillators)
- Medical
- Preclinical PET (animal)
- Safety and security

- **SiPM best suited to read out scintillators**
 - Radiation detectors (α , β , γ , n)
- **CSPs: advantageous for small detectors/handhelds**
 - Robust
 - Low voltage
 - Can be battery powered
 - Insensitive to magnetic fields
- **4x4 and 8x8 arrays:**
 - large area- / multichannel-detectors



Chip Size
Package
(CSP)



4 x 4 Array



EBV portfolio



Sensor vs. supplier matrix – Environmental sensing

Type		ams OSRAM	BROADCOM connecting everything	Infineon	MICROCHIP	NXP	onsemi	RENESAS	SciSense	ST life augmented	VISHAY
Environmental	Temperature	●			●	●	●			●	●
	Humidity/ Temperature							●	●		
	Barometric pressure/ Temperature					●			●	●	
	IAQ							●	●		
	OAQ							●			
	Smoke detection				●			●			
	VOC							●	●		
	Rain fall						●				
	CO2			●				●			
	Smart Sensor	●				●					
	Hydrogen							●			
	Flammable gas							●			
	Wireless sensor	●					●				
	Fire detection		●								
	Liquid flow							●	●		
	Gas flow							●	●		
	Lightning								●		
	Thermopile							●			
	Radiation		●								








ams OSRAM



Ams OSRAM – AS62xx Family

Temperature sensor product portfolio

	New	Actual			
	AS6221T	AS6221	AS6212	AS6214	AS6218
					
Accuracy	±0.09°C @ 20°C... 42°C ±0.12°C @ 0°C ...60°C	± 0.09°C @ 20..42°C ± 0.3°C @ -40..125°C	±0.3°C @ -40...-10°C ± 0.2°C @ -10... 65°C ±0.3°C @ 65... 85°C ±0.5°C @ 85...125°C	±1.0°C @ -40...0°C ± 0.4°C @ 0... 65°C ±1.0°C @ 65...125°C	±1.0°C @ -40...0°C ±0.8°C @ 0... 65°C ±1.0°C @ 65...125°C
Resolution	16bit	16bit	16bit	16bit	16bit
Temp-Range	0°C to +60°C	-40°C to +125°C	-40°C to +125°C	-40°C to +125°C	-40°C to +125°C
Package	6pin WLCSP* 1.5x1.0x0.5mm	6pin WLCSP 1.5x1.0x0.6mm	6pin WLCSP 1.5x1.0x0.6mm	6pin WLCSP 1.5x1.0x0.6mm	6pin WLCSP 1.5x1.0x0.6mm
Supply	1.71 – 3.6 V 0°C to 60°C	1.71 - 3.6V (0°C to 125°C) 2.00 - 3.6V (-40°C to 125°C)	1.71 - 3.6V (0°C to 125°C) 2.0 - 3.6V (-40°C to 125°C)	1.71 - 3.6V (0°C to 125°C) 2.0 - 3.6V (-40°C to 125°C)	1.71 - 3.6V (0°C to 125°C) 2.0 - 3.6V (-40°C to 125°C)
Power Consumption	6µA @ 4Hz 1.6µA typ. @1Hz 2.1 µA (max) @1Hz	6µA @ 4Hz 1.6µA typ. @1Hz 2.1 µA (max) @1Hz	6µA @ 4Hz 1.6µA typ. @1Hz 2.1 µA (max) @1Hz	6µA @ 4Hz 1.6µA typ. @1Hz 2.1 µA (max) @1Hz	6µA @ 4Hz 1.6µA typ. @1Hz 2.1 µA (max) @1Hz
	0.1µA typ. / standby (25°C)	0.1µA typ (standby (25°C)	0.1µA typ (standby (25°C)	0.1µA typ (standby (25°C)	0.1µA typ (standby (25°C)
Conversion Time	36ms (typ)	36ms (typ)	36ms (typ)	36ms (typ)	36ms (typ)
Interface	I2C	I2C	I2C	I2C	I2C
Factory calibrated	yes	yes	yes	yes	yes
Alert output	yes	yes	yes	yes	yes
I2C addresses	8 (0x54 to 0x5B)	8 (0x44 to 0x4B)	8 (0x44 to 0x4B)	8 (0x44 to 0x4B)	8 (0x44 to 0x4B)

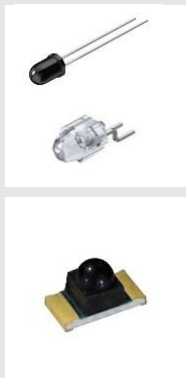
*The T has a different pinout (matching TI TMP117) and reduced height (500µm nom instead of 600µm). Beside that there is no difference



Fire/Smoke detection

Photoelectric effect - IRED & PIN Photo Diode

Emitter



Product:

IRED in T1 (3 mm), T1 ¾ (5 mm), Surface Mount Radial (SMR) and CHIPLED
Half angle opt. from ± 3 to $\pm 30^\circ$
Devices with UL recognition available on request (marked with E-#)

[SFH 4059](#)
[SFH 4056](#)
[SFH 4350](#)
[SFH 4356](#)
[SFH 4544](#)
[SFH 4547](#)
[SFH 4550](#)
[SFH 4554](#)
[SFH 4551](#)
[SFH 4558](#)

PIN Photo Diode



Product:

T1 ¾ (5 mm), Surface Mount Radial (SMR) Sidelooker
Half angle options from ± 10 to $\pm 65^\circ$

[SFH 203 FA](#)
[SFH 213 FA](#)
[SFH 2500/5 FA](#)
[SFH 205 FA](#)
[SFH 235 FA](#)
[SFH 206 K](#)



Building Blocks

amun **OSRAM**

Driver

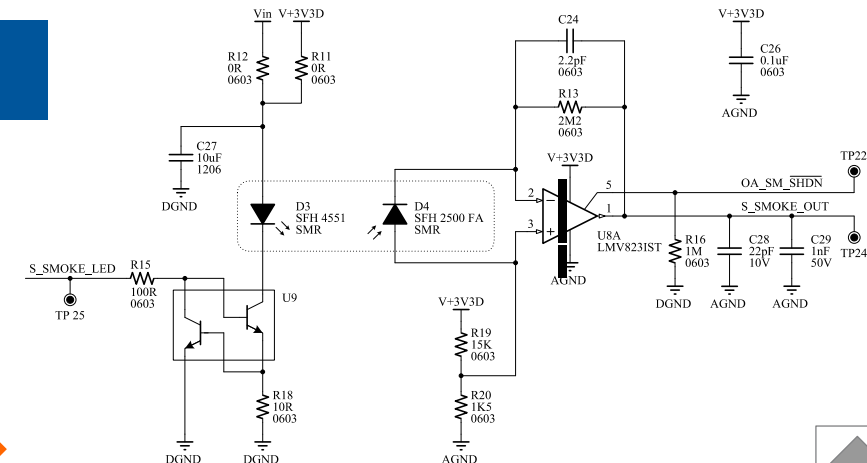
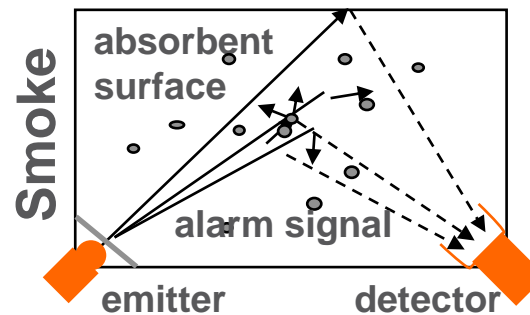
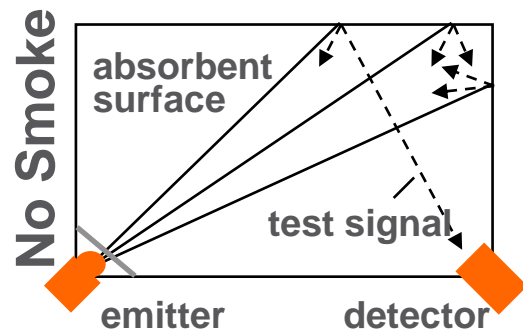
IRED

Smoke Chamber

amun **OSRAM**

PIN Photo Diode

Amplifier



ams – Components for Optical Smoke Sensor

AS7343 – 14 Channel Spectral Sensor

Key features

- 12 spectral channel within 400nm – 1000nm
 - 2 additional general-purpose channels (clear, flicker detection)
- Increased sensitivity compared to AS7341 by up to 8x (depending on channel)
- Improved outer band suppression of spectral filters
- Automatic ADC re-configuration for multi-channel read-out
- Improved flicker detection (continuous flicker detection)
 - Increased flicker sensitivity (2nd PD)
 - Decreased I2C Interface loading (8-bit mode)
- I2C Interface with 1MHz
- Low profile package size with 3.1 mm x 2 mm x 1 mm



→ Increase **reliability** also in challenging environments (**bathroom, spa, kitchen**)

→ **Faster** response

→ **Smoke type analysis** for further insight or new applications (**fume hood**)

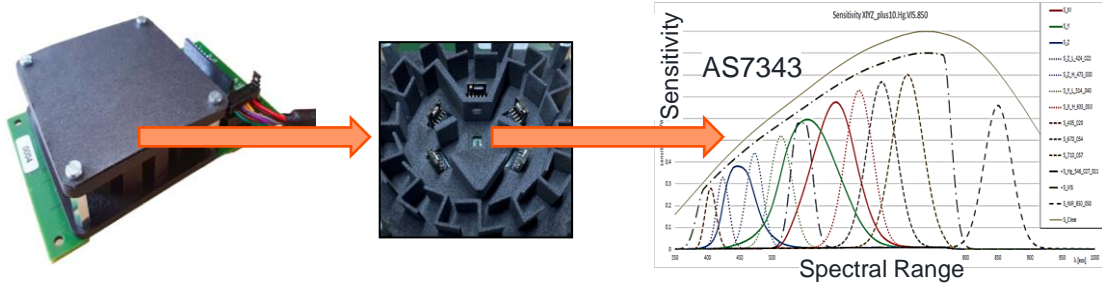
	F1	F2	FZ	F3	F4	FY	F5	FXL	F6	F7	F8	NIR
Peak [nm]	400	425	440	473	514	555	547	595	635	685	745	850
FWHM [nm]	30	22	55	30	40	100	35	80	50	55	60	54



ams OSRAM – Evaluation kit for multi-criteria smoke / fire detector

AS7343 smoke / fire detector with pre-integrated smoke chamber, ready for in-application testing

Hardware Infrastructure

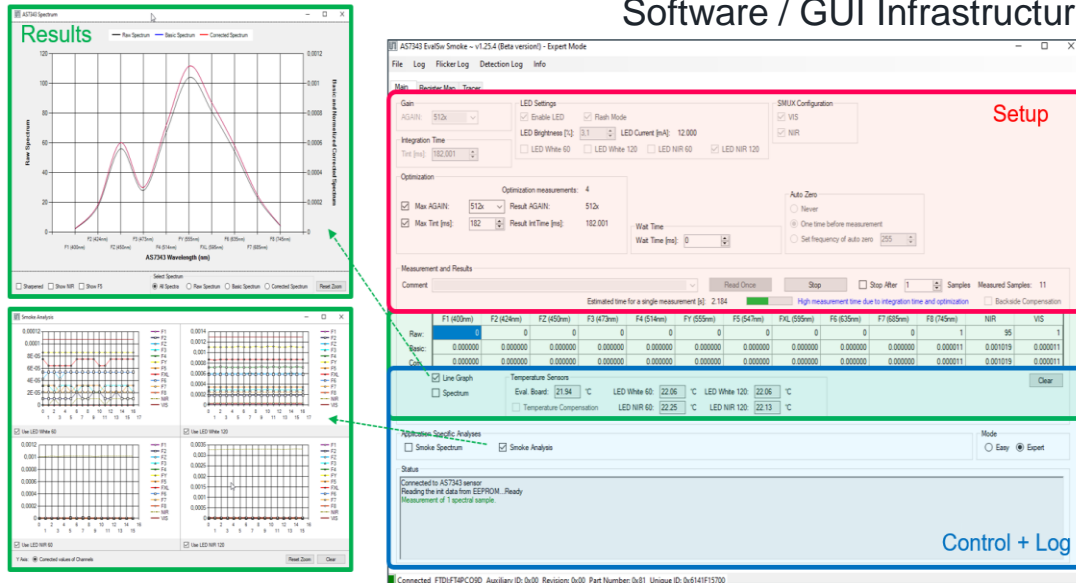


AS7343 Smoke Detector evaluation kit consists of the following ams OSRAM key components:

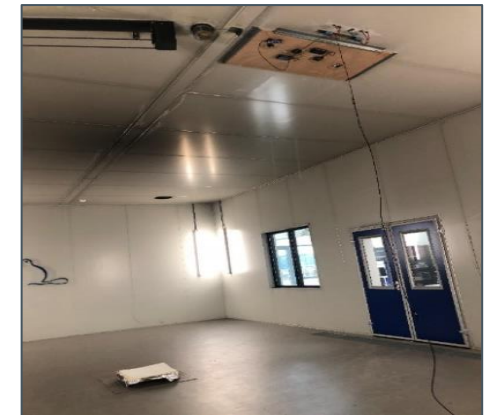
- 1x **AS7343** multi spectral sensor
- 2x **SFH4171S** NIR LEDs emitters
- 2x **LUW CRBP** white LEDs emitters

Integration is provides a customized smoke chamber and dedicated measurement software (incl. GUI) for performing quantifiable detection / identification measurements

Software / GUI Infrastructure



Professional Lab Infrastructure for EvalKit Testing

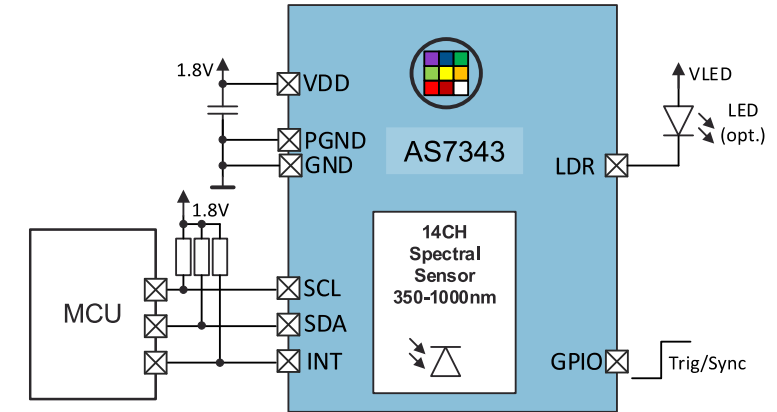
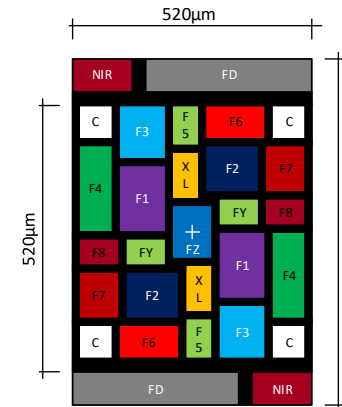


ams – AS7343 – 14 Channel Spectral Sensor

Next generation multi-purpose spectral sensor

Key features

- 12 spectral channel within 400nm – 1000nm
 - 2 additional general-purpose channels (clear, flicker detection)
- Increased sensitivity compared to AS7341 by up to 8x (depending on channel)
- Improved outer band suppression of spectral filters
- Automatic ADC re-configuration for multi-channel read-out
- Improved flicker detection (continuous flicker detection)
 - Increased flicker sensitivity (2nd PD)
 - Decreased I2C Interface loading (8-bit mode)
- I2C Interface with 1MHz
- Low profile package size with 3.1 mm x 2 mm x 1 m



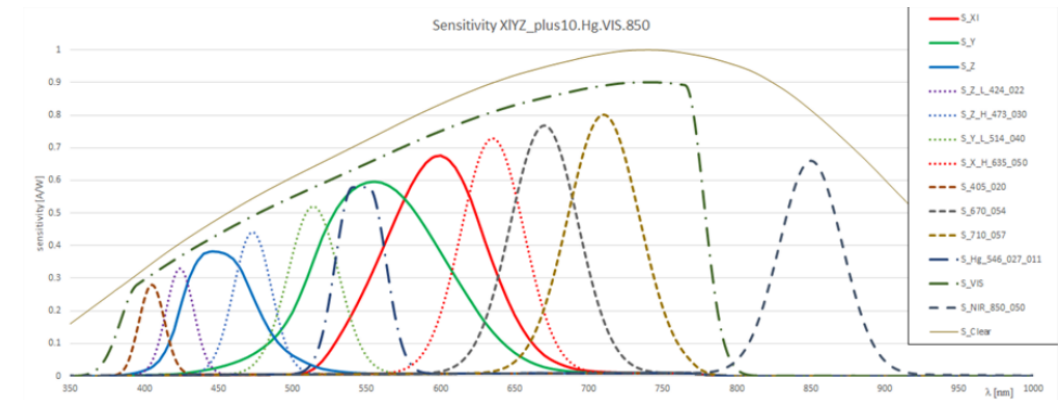
Applications

Emissive:

- Spectral ALS with CCT measurement based on a precise light source identification for camera AWB (Spectral re-construction of light)
- Flicker compensated camera operation and image

High precision reflective color point and spectral measurements:

- Such as color measurements or lateral flow test applications



	F1	F2	FZ	F3	F4	FY	F5	FXL	F6	F7	F8	NIR
Peak [nm]	400	425	440	473	514	555	547	595	635	685	745	850
FWHM [nm]	30	22	55	30	40	100	35	80	50	55	60	54



Broadcom



Broadcom – ezPyro

Pyroelectric Detectors – IR-Detector for Gas sensing:

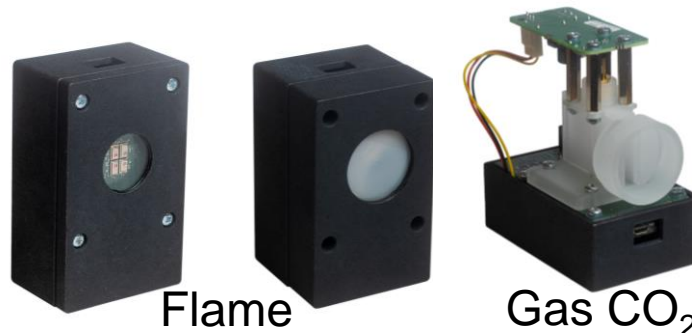
IR-Sensor with monochromatic band pass filters for 2-20 μm
→ for integration in selective **gas detection**,

Sensor needs additional light source :

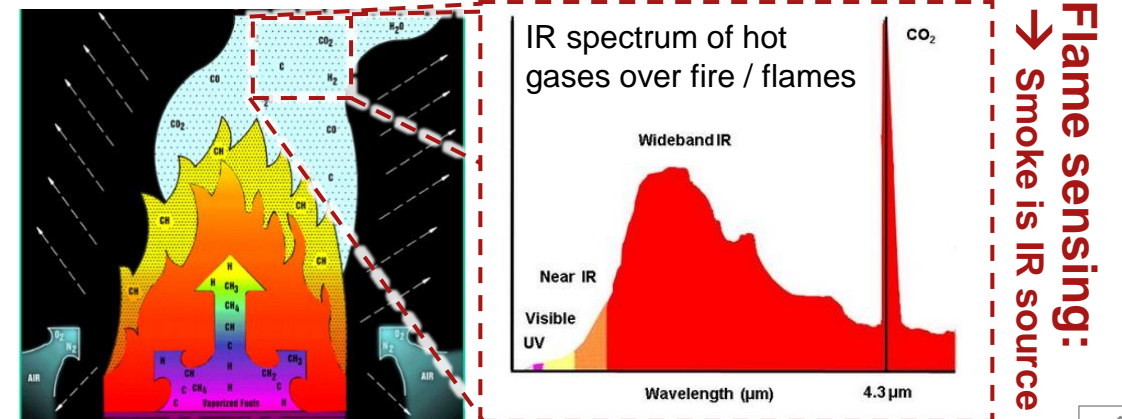
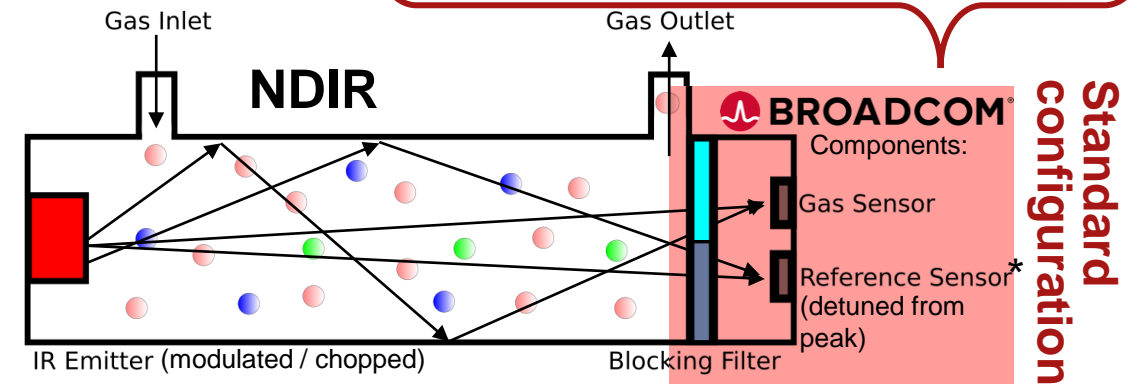
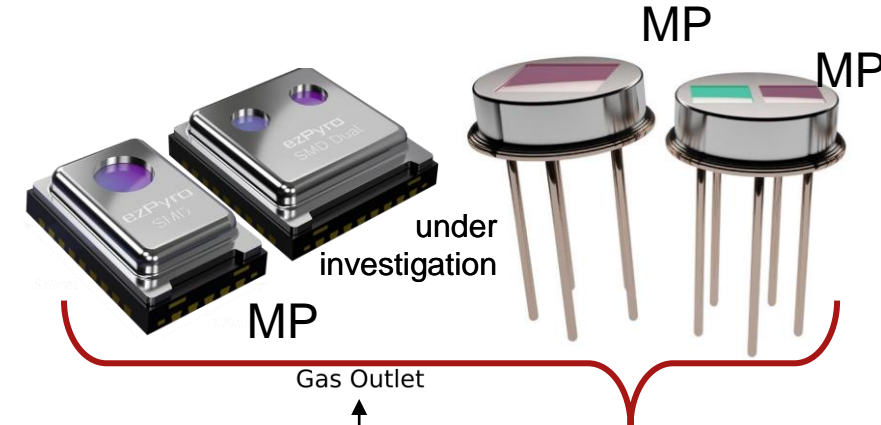
- separate IR emitter (bulb or MEMS) for standard gas analysis
- Hot gases (e.g. hot CO_2 / H_2O in flames)

Due to technology and ambient IR radiation
only evaluation of **signal modulation / flicker**
→ good **measurement data**

Eval kits are available:
→ for PoC & feasibility



*Typically reference sensor(s) with detuned filter (from molecule resonance) in same light path for compensation of ambient light or moving heat sources like humans

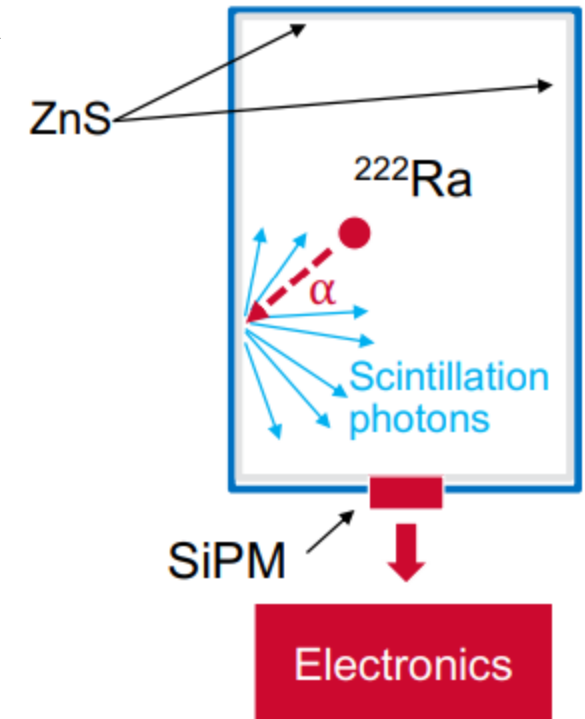


Radon sensing

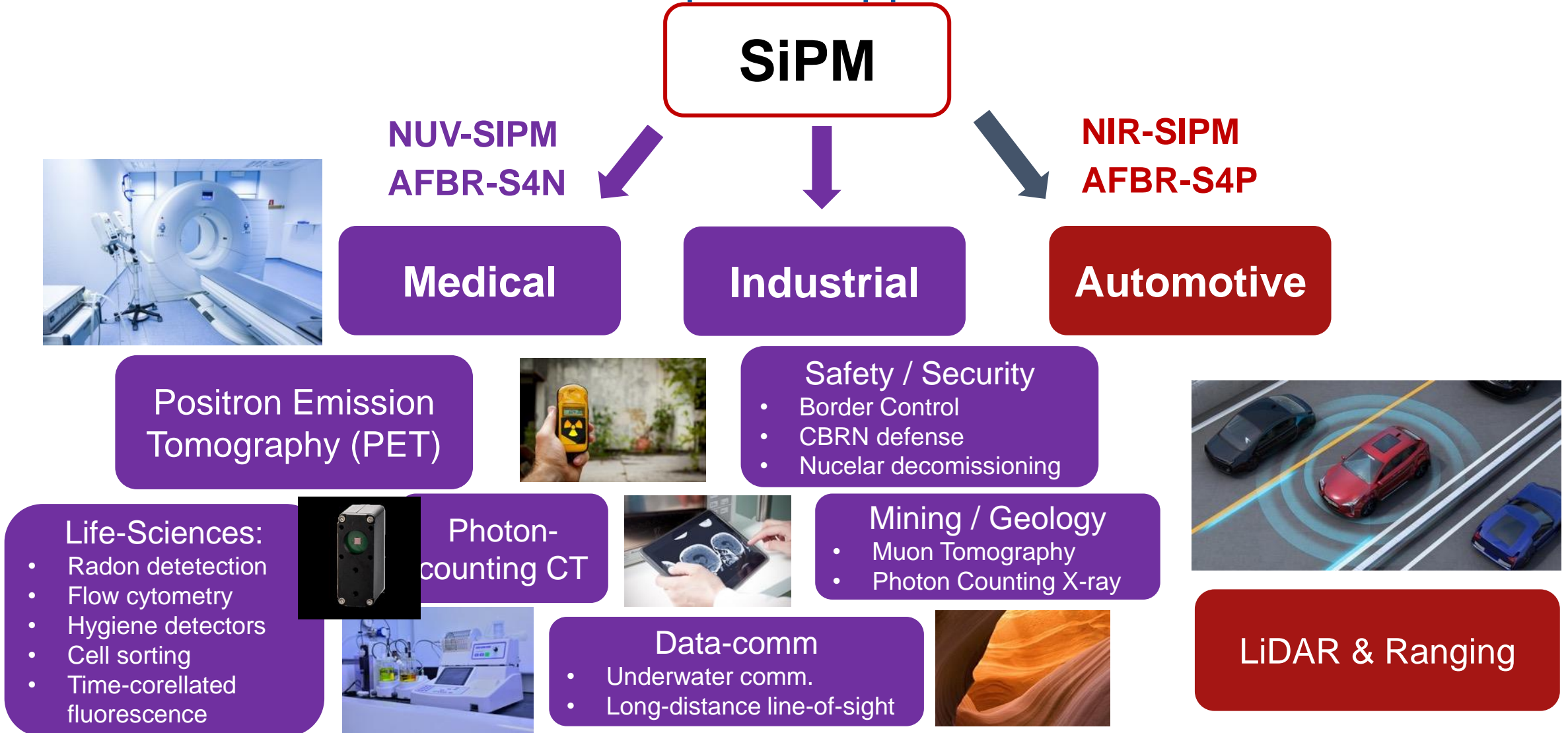
Radon is a dangerous naturally occurring radioactive gas coming out of soil.

Issues in non-sealed basements at bad ventilation → risk of lung cancer.

Broadcom SiPM can be used as a low voltage, high reliable, instantaneous (in situ) measurement method



AFBR-S4 Silicon Photomultipliers: Applications



Infineon

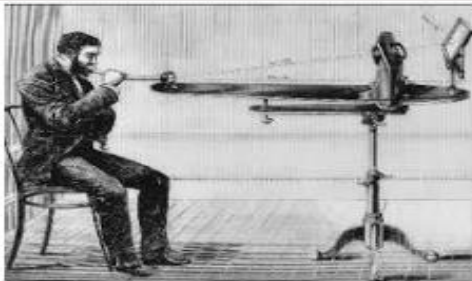


Infineon – PAS CO₂

XENSIV™ environmental sensor based on the photoacoustic principle

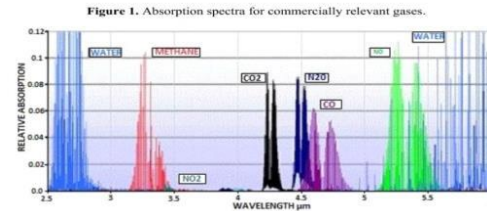
Photoacoustic effect

Inventor

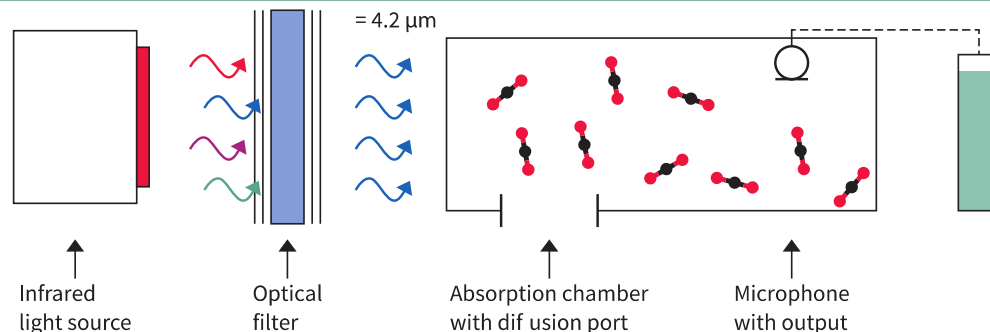


A.G. Bell 1880

Infrared spectrum

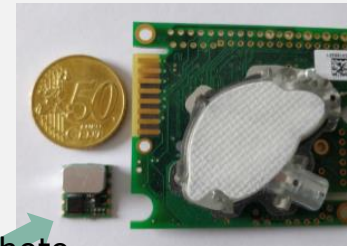


Working principle



Measuring air quality with a microphone

World's smallest PAS module



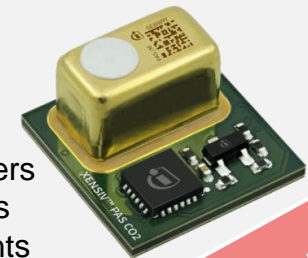
Infineon's photo Acoustic CO₂ sensor

Key features

- Unprecedented small form factor in an SMD module
- ppm reading of the CO₂ level
- Operating range
 - CO₂: 0 ppm to 10,000 ppm
 - Temperature: 0 °C to 50 °C
- Supply voltage
 - VDDIO = 3.3 V
 - VDD12 V = 12 V
- Interface: UART, I2C, PWM

Applications

- Ventilation control/building automation
- Smart appliances such as air purifiers, air conditioners
- Consumer devices for air quality monitoring, such as thermostats, weather stations and personal assistants
- Smart indoor lighting
- In-cabin air quality monitoring



Available



Comparison of CO₂ sensing technologies

XENSIV™ PAS CO2 beats NDIR in size and cost, with the same or even better performance

Parameter	XENSIV™ PAS CO2	NDIR	EC	eCO ₂
Size	●	●	●	●
Cost	●	●	●	●
Accuracy	●	●	●	●
Long term drift	●	●	●	●
Warming time	●	●	●	●
Response time	●	●	●	●
Selectivity	●	●	●	●
Humidity impact	●	●	●	●
Power consumption	●	●	●	●

worst ● ● best

PAS = Photo Acoustic Spectroscopy
NDIR = Non Dispersive Infrared Light

EC = Electrochemical
eCO₂ = equivalent CO₂



Infineon – Pressure & Temperature sensor portfolio

Miniaturized, lowest power consumption & highest precision

Product portfolio



DPS310

Low power & high precision



DPS368

DPS310 +
robustness against
water, dust &
humidity

Key features



Small size

DPS310: 2x2.5x1.0 mm
DPS368: 2x2.5x1.1 mm



Low energy consumption

Peak current: 345 μ A (pressure measurement)
Standby: 0.5 / 1.0 μ A



Excellent temperature stability

Pressure temperature sensitivity:
0.5 Pa / $^{\circ}$ C



High sensitivity

Precision: \pm 0.002 hPa (2cm)
Rel. accuracy: \pm 0.06 hPa
Abs. accuracy: \pm 1.0 hPa



Robustness

DPS368 is robust against water (IPx8)¹, dust & humidity

Key value

Space-saving
integration into device

Increased battery
lifetime

No drift over wide
temperature range

Precise detection
of altitude, activity, air
volume, etc.

Easy operation in harsh
environment

1. Pressure sensor fully functional after 50 m under water for 1 hour



Infineon – DPS310 & DPS368

Pressure & Temperature sensors



DPS310

Low power & high precision



DPS368

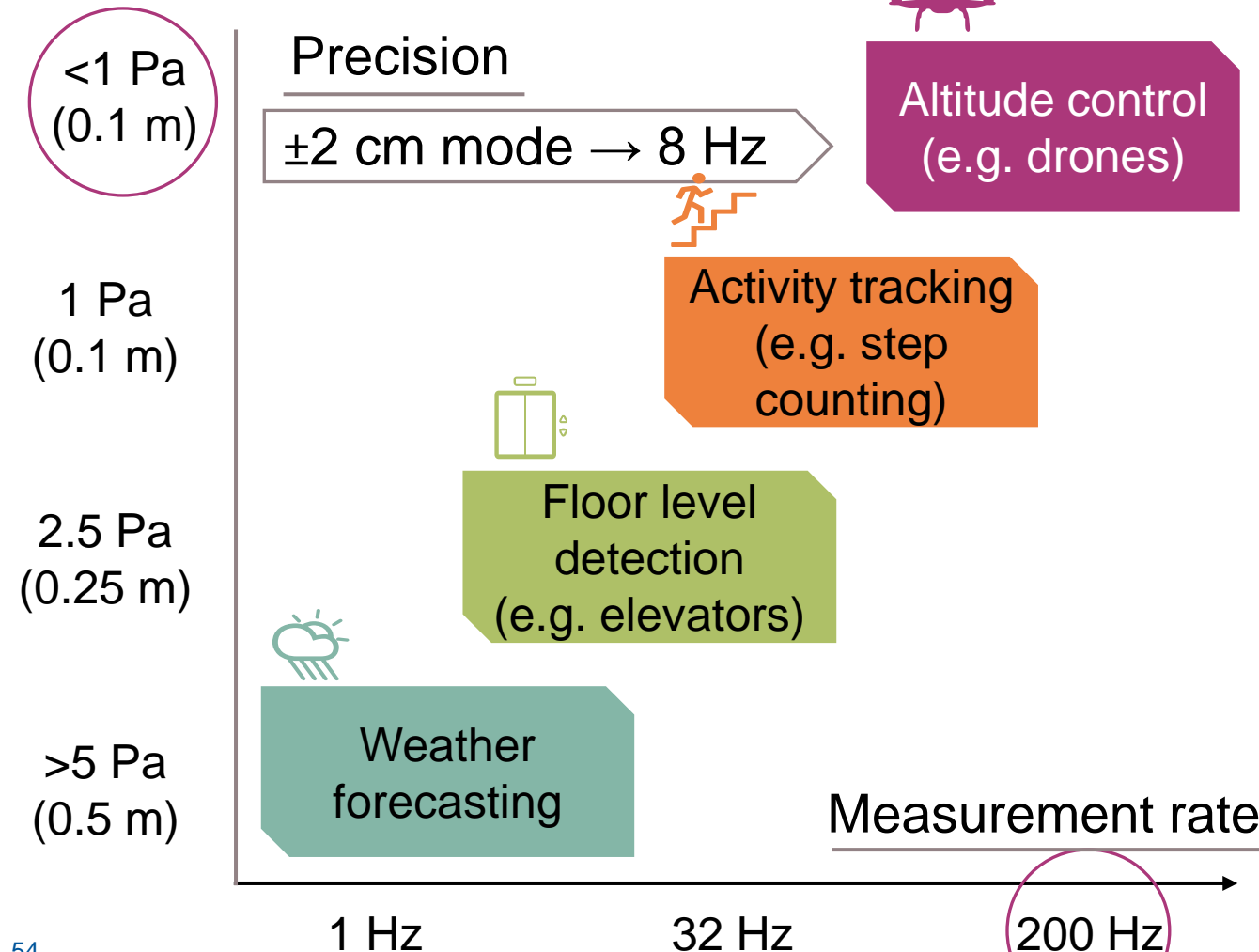
DPS310 +
robustness against
water, dust &
humidity

- **Operation range:** Pressure: 300 – 1200 hPa. Temperature: -40 – 85 °C.
- **Pressure sensor precision:** ± 0.002 hPa (or ± 0.02 m) (high precision mode).
- **Relative/Absolute accuracy:** ± 0.06 hPa (or ± 0.5 m)/ ± 1 hPa (or ± 8 m)
- **DPS368 only - IPx8 certified:** Temporary immersion of 50m for 1 hour
- **Temperature accuracy:** $\pm 0.5^\circ\text{C}$.
- **Pressure temperature sensitivity:** 0.5Pa/K
- **Measurement time:** Typical 27.6 ms for standard mode (16x). Minimum: 3.6 ms for low precision mode.
- **Average current consumption:** 1.7 μA for pressure measurement, 1.5 μA for temperature measurement @ 1Hz sampling rate, standby: 0.5 μA .
- **Supply voltage:** VDDIO: 1.2 – 3.6 V, VDD: 1.7 – 3.6 V.
- **Operating modes:** Command (manual), Background (automatic), and Standby.
- **Calibration:** Individually calibrated with coefficients for measurement correction.
- **FIFO:** Stores up to 32 pressure or temperature measurements.
- **Interface:** I2C and SPI (both with optional interrupt)
- **Package dimensions:** 8-pin PG-VLGA-8-2 , 2.0 mm x 2.5 mm x 1.1 mm.



Infineon – Pressure sensor

Low energy consumption



Different operational modes that can be optimized for **different use cases**



Pressure sensors use **over-sampling** and **time measurement**

Operation modes:

- High precision mode
- Standard mode
- Low power mode
- Ultra-low power mode



Infineon – Pressure sensors

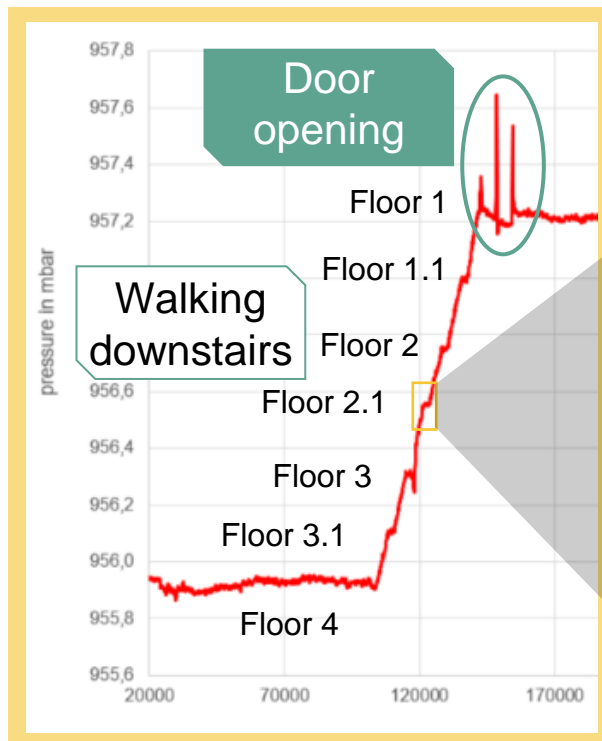
High sensitivity



Sensors have a resolution of up to 0.002 hP (2 cm)

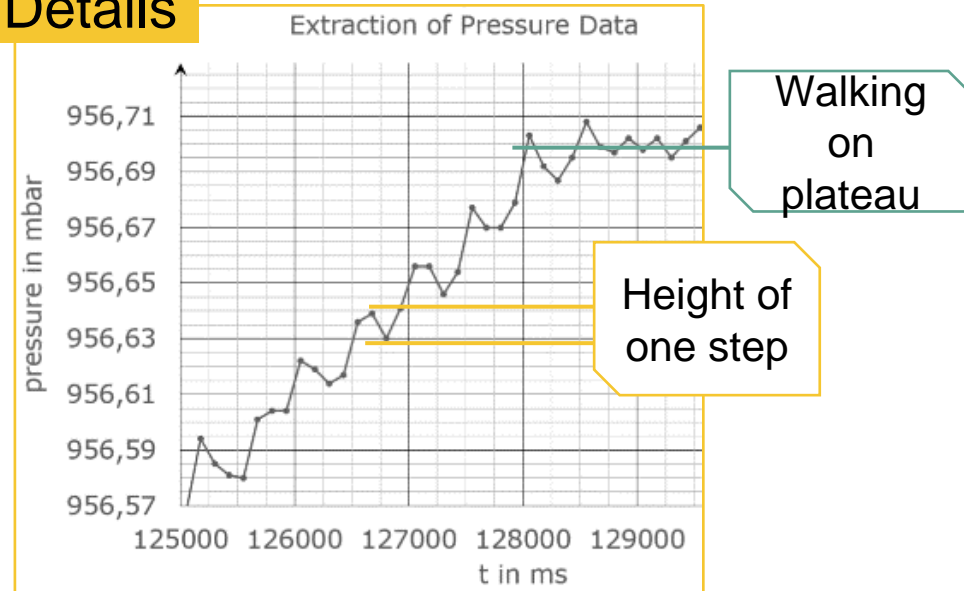


Low pressure noise of only ~0.4 Pa



A walk through the office with **DPS368**

Details



Infineon – Sensor APIs

- Extensive API
- ModusToolbox
- Multi-platform support

The screenshot displays the Eclipse IDE for ModusToolbox. The main editor shows the 'sensor-xensiv-pasco2' API reference page, which includes a search bar and a table of available sensors. The 'Library Manager' window is open, showing a list of libraries with checkboxes for selection. A red box highlights the 'sensor-xensiv-pasco2' library, which is currently selected. The 'Console' window at the bottom shows the output of the application, displaying sensor data for Pressure, Temperature, and CO2.

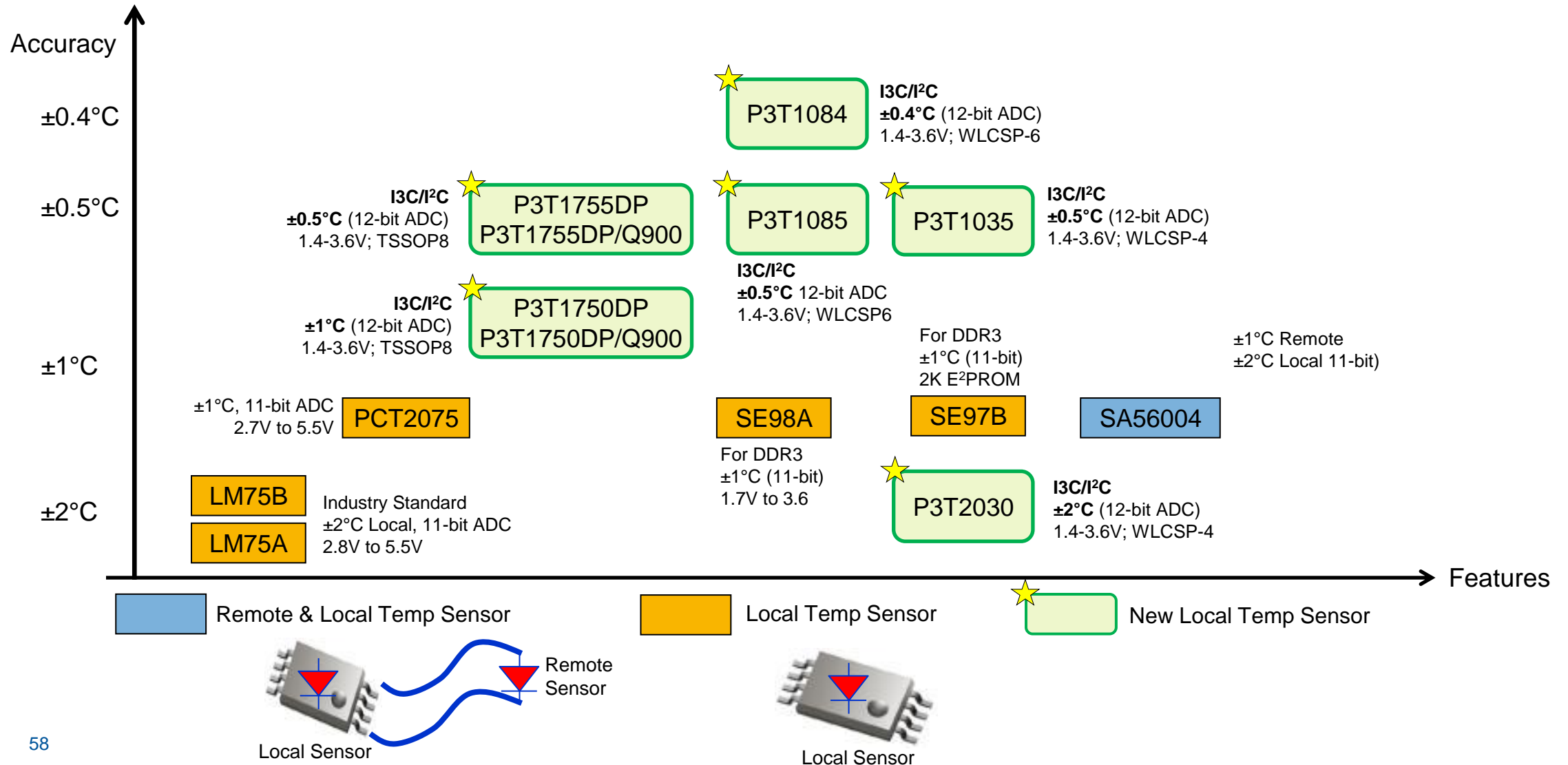
Name	Shared	Version
<input type="checkbox"/> multi-half-bridge	<input type="checkbox"/>	Latest 5.X release
<input checked="" type="checkbox"/> retarget-io	<input checked="" type="checkbox"/>	1.3.0 release
<input type="checkbox"/> rgb-led	<input type="checkbox"/>	1.2.1 release
<input type="checkbox"/> sensor-light	<input type="checkbox"/>	1.1.0 release
<input type="checkbox"/> sensor-motion-bmi160	<input type="checkbox"/>	1.1.1 release
<input type="checkbox"/> sensor-orientation-bmx160	<input type="checkbox"/>	1.0.1 release
<input type="checkbox"/> sensor-xensiv-bgt60trxx	<input type="checkbox"/>	0.6.3 release
<input checked="" type="checkbox"/> sensor-xensiv-dps3xx	<input checked="" type="checkbox"/>	1.0.0 release
<input checked="" type="checkbox"/> sensor-xensiv-pasco2	<input checked="" type="checkbox"/>	1.0.0 release
<input type="checkbox"/> serial-flash	<input type="checkbox"/>	1.3.0 release
<input type="checkbox"/> thermis	<input type="checkbox"/>	
<input type="checkbox"/> xensiv-	<input type="checkbox"/>	



NXP

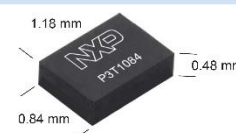
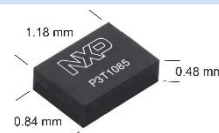


NXP – Digital Temperature Sensors portfolio at a glance



NXP – Digital Temperature Sensors portfolio at a glance

	P3T175 ⁰ DP & DP/Q900	P3T175 ⁵ DP & DP/Q900	P3T108 ⁵ UK	P3T108 ⁴ UK	P3T103 ⁵ xUK (coming up soon)	P3T2030xUK (coming up soon)
Supply voltage	1.4V ~ 3.6V	1.4V ~ 3.6V	1.4V ~ 3.6V	1.4V ~ 3.6V	1.4V ~ 1.98V	1.4V ~ 1.98V
Temp range	-40°C ~ 125°C	-40°C ~ 125°C	-40°C ~ 125°C	-40°C ~ 125°C	-40°C ~ 125°C	-40°C ~ 125°C
Interface	I2C (up to 3.4 MHz HsM) I3C(up to 12.5MHz) In-Band-Interrupt(IB) Low power(push-pull)	I2C (up to 3.4 MHz HsM) I3C(up to 12.5MHz) In-Band-Interrupt(IB) Low power(push-pull)	I2C (up to 3.4 MHz HsM) I3C(up to 12.5MHz) In-Band-Interrupt(IB) Low power(push-pull)	I2C (up to 3.4 MHz HsM) I3C(up to 12.5MHz) In-Band-Interrupt(IB) Low power(push-pull)	I2C (up to 3.4 MHz HsM) I3C (up to 12.5MHz) In-Band-Interrupt(IB) Low power(push-pull)	I2C (up to 3.4 MHz HsM) I3C (up to 12.5MHz) In-Band-Interrupt(IB) Low power(push-pull)
Temp resolution	12-bit (0.0625°C)	12-bit (0.0625°C)	12-bit (0.0625°C)	12-bit (0.0625°C)	12-bit (0.0625°C)	12-bit (0.0625°C)
Max temp accuracy	±1°C @ -40°C ~ 125°C	±1°C @ -40°C ~ 125°C ±0.5°C @ -20°C ~ 85°C	±1°C @ -40°C ~ 125°C ±0.5°C @ -20°C ~ 85°C	±1°C @ -40°C ~ 125°C ±0.4°C @ -20°C ~ 85°C	±2°C @ -40°C ~ 125°C & >1.62V ±0.5°C @ 0°C ~ 70°C & >1.62V	±2°C @ -40°C ~ 125°C & >1.62V
I2C Alert pin	YES	YES	YES	YES	NO	NO
Device address	32 (3 address pins)	32 (3 address pins)	4 (1 address pin)	4 (1 address pin)	8 (fixed by OTP)	8 (fixed by OTP)
I2C/I3C	YES	YES	YES	YES	YES	YES
Quiescent current	6uA	6uA	6uA	6uA	6uA	6uA
Package	TSSOP8 3.0 mm x 3.0mm	TSSOP8 3.0 mm x 3.0mm	WLCSP-6 (3 x 2) 0.84 mm x 1.18 mm, 0.4 mm pitch	WLCSP-6 (3 x 2) 0.84 mm x 1.18 mm, 0.4 mm pitch	WLCSP-4 (2x2) 0.88 mm x 0.93 mm, 0.4 mm pitch	WLCSP-4 (2x2) 0.88 mm x 0.93 mm, 0.4 mm pitch
Note	AEC-Q100 Grade 1 three address pin – 32 addresses	High accuracy ±0.5°C AEC-Q100 Grade 1 three address pin – 32 addresses	High accuracy ±0.5°C one address pin – four addresses	High accuracy ±0.4°C one address pin – four addresses	High accuracy ±0.5°C Smallest package fixed address – 8 parts	Low pin count Smallest package fixed address – 8 parts



NXP – Pressure Sensor Portfolio

MPX10/12/53

D G

10...53 kPa
SOP, Unibody

Uncompensated

High sensitivity analog output
Need external circuit for compensation and amplification

A – Absolute
D – Differential
G – Gauge
V – Vacuum

MPX2 Series

A D G V

10...300 kPa
ChipPak, Unibody

Temperature Compensated

Integrated temperature compensation
Need external circuit for amplification

MPX7 Series

D G

±2...±25 kPa
SOP

Integrated Pressure Sensor

Integrated signal conditioning for temperature compensation, linearization and amplification

MPX4 Series

A D G

6...250 kPa
SOP, SSOP, Unibody

MPX5 Series

A D G V

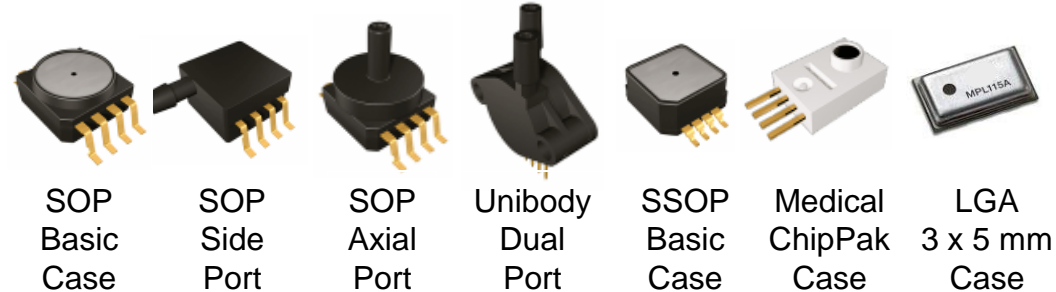
4...1'000 kPa
SOP, SSOP, Unibody

MPX6 Series

A

100...400 kPa
SOP, SSOP

PACKAGE EXAMPLES



MPL3115 (Digital I²C)

A

115 kPa Smart Baro/Pressure
3 x 5 mm LGA

Integrated Digital Pressure Sensor

I²C Digital Interface with digitized output in Pascal or meters.

MPL115 (SPI)

A

115 kPa Smart Baro/Pressure
3 x 5 mm LGA

SPI Interface



NXP – MPL3115A2, MPL3150A2, FXPQ3115BV

Precision Pressure Sensor / ALTIMETER

DIFFERENTIATING POINTS

- Internally compensated, **software is not needed**
- Direct reading pressure in **Pascal or Altitude**, plus **Temperature**

PRODUCT FEATURES

- **Pressure resolution: 1.5 Pa**
- **Guaranteed drift over time (<20 Pa)** for use in “pseudo differential mode”
- Pressure ranges: **20 – 110 kPa** and **50-150 kPa**
- **1.95V to 3.6V** supply voltage
- I²C digital interface
- Interrupt driven events
- 32-Sample FIFO
- **Low power down to 8µA**

PART NUMBER	INTERFACE	PRESSURE RANGE	RESOLUTION	RELATIVE ACCURACY	GEL COATING
MPL3115A2	I ² C	20kPa-110kPa	1.5Pa	0.05kPa	Standard
MPL3150A2	I ² C	50kPa-150kPa	1.5Pa	0.05kPa	Standard
FXPQ3115BV	I ² C	20kPa-110kPa	1.5Pa	0.05kPa	Bio Compatible



Package
3 x 5 x 1.1 mm LGA

Key Applications

Medical, Industrial & Consumer

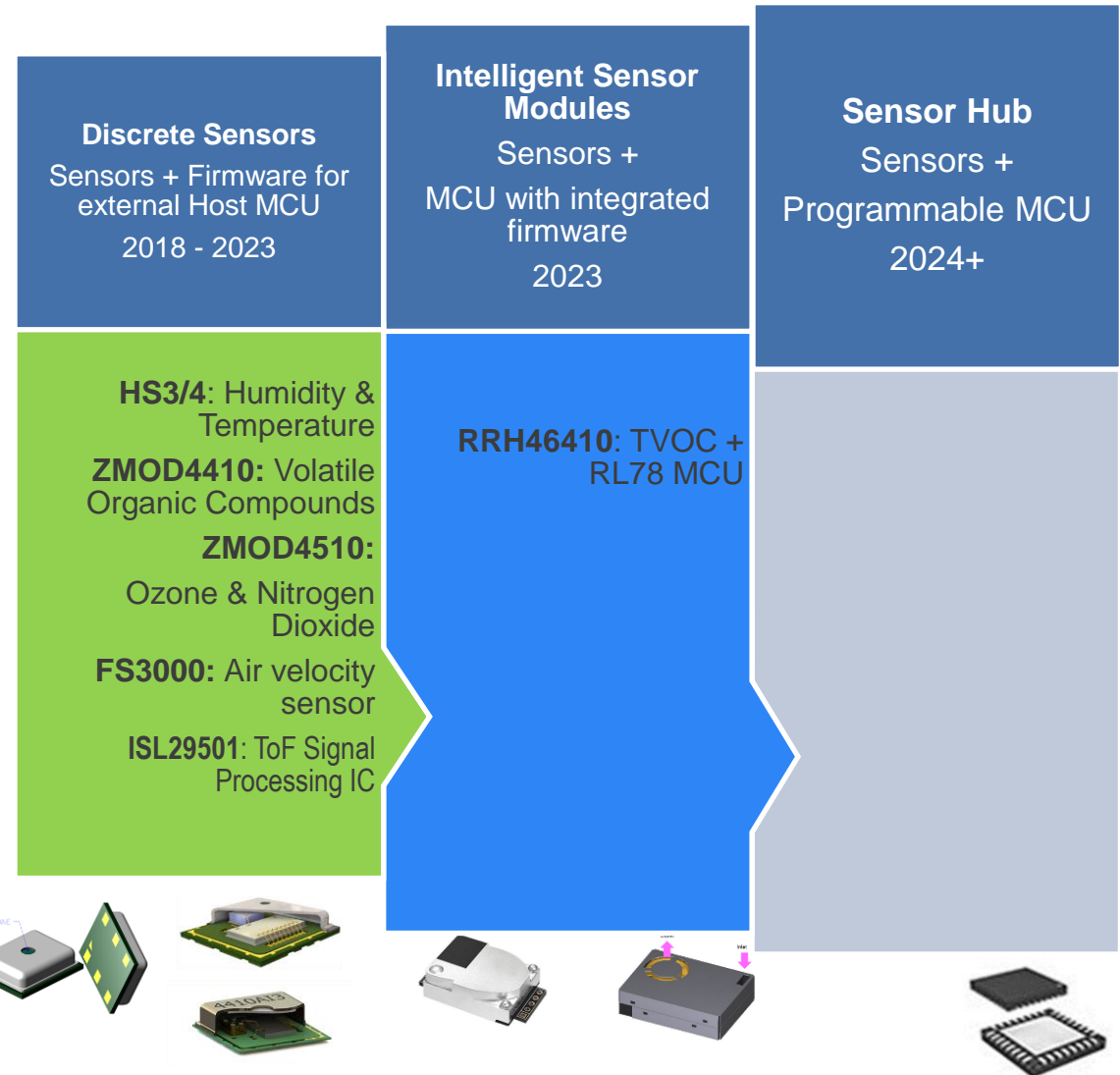
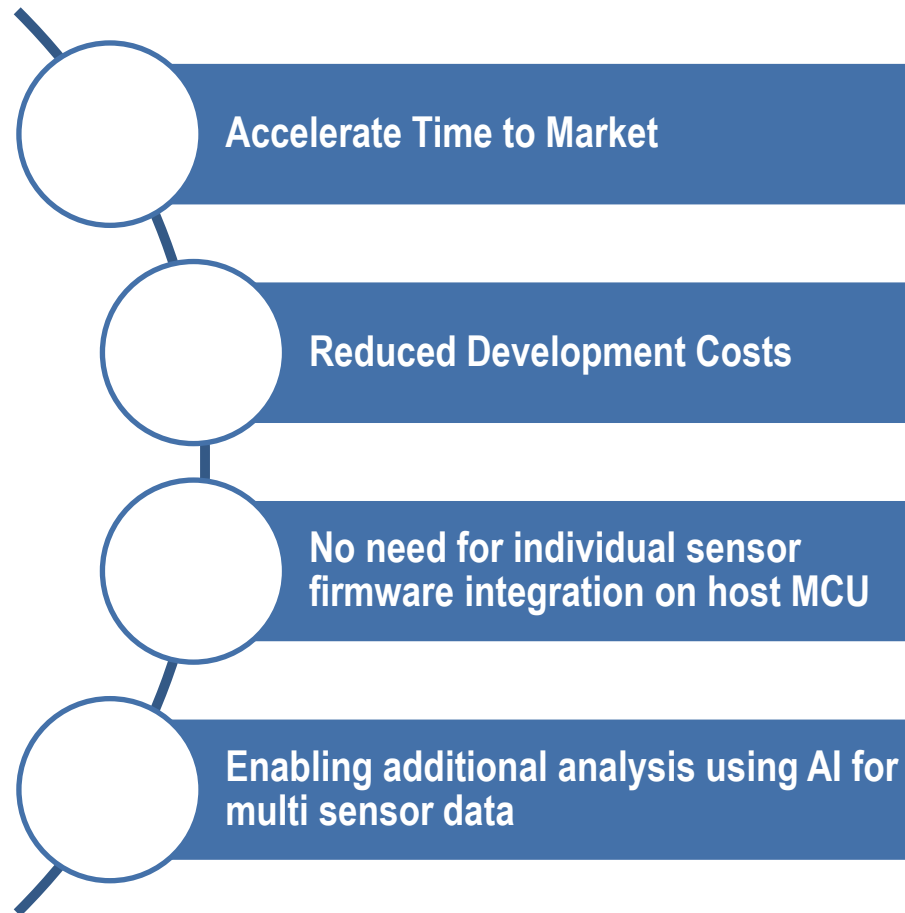
- Altimeters/navigation systems
- Weather station equipment
- Health / Activity Monitors
- Oxygen Concentrators
- HVAC/Ventilation system
- Tank pressure monitor
- Medical respiratory
- E-inhalers
- Boilers



Renesas



Renesas –Environmental Sensing Solutions

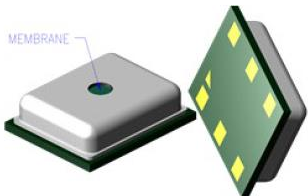


Renesas – HS4x & HS3x

Digital Relative Humidity & Temperature Sensor



2.5 × 2.5 × 0.9 mm
DFN-style 8-LGA package



3.0 × 2.41 × 0.8 mm
DFN-style 6-LGA package

RENESAS HS4X

Features	Benefits	Use Cases
<ul style="list-style-type: none"> ±1.5% Relative Humidity Accuracy (HS4001, HS4101) Temperature sensor accuracy of ±0.2°C (HS4001/2, HS4101/2) Fast RH response time (Typical 3 seconds) 14-bit resolution, 0.01%RH (Typical) Low power consumption, 0.62µA average Digital and Analog Output Supply voltage, 1.71V to 3.6V 	<ul style="list-style-type: none"> Digital I²C Output (HS400x) Analog Output (HS410x) Very low power consumption Silicon-carbide capacitive sensing element Excellent stability against aging Highly robust protection from harsh environmental conditions and mechanical shock Automotive Qualified, -40°C to +125°C 	<ul style="list-style-type: none"> monitor ambient environment monitor temperature and rh levels inside IoT devices monitor water ingress monitor condensation build up preventative maintenance

RENESAS HS3X

Features	Benefits	Use Cases
<ul style="list-style-type: none"> ±1.5% relative humidity accuracy (HS3001) Temperature sensor accuracy of ±0.2°C (HS3001, HS3002) Fast RH response time (Typical 3-6 seconds) 14-bit resolution, 0.01% RH (Typical) Low power consumption, 1.0µA average (one RH + T measurement per second) Extended supply voltage, 1.8 to 5.5 V 	<ul style="list-style-type: none"> Digital I²C output Very low power consumption Highly robust protection from harsh environmental conditions and mechanical shock Excellent stability against aging Silicon carbide capacitive sensing element 	<ul style="list-style-type: none"> monitor ambient environment monitor temperature and rh levels inside IoT devices monitor water ingress monitor condensation build up preventative maintenance



Renesas – HS300x & HS310x

Digital Relative Humidity & Temperature Sensor

Features:

- Silicon carbide structure
- **$\pm 1.5\%RH$, $\pm 0.2^\circ C$ accuracy** (HS3001)
- $\pm 3.8\%RH$, $\pm 0.3^\circ C$ accuracy (HS3004)
- Fast RH response time (Typ. 6 seconds)
- 0.1%RH/Yr drift
- 14-bit resolution: 0.01%RH (Typ.)
- Low power consumption: **1.0 μA average**
- Digital/Analog output
- Extended supply voltage: 1.8V to 5.5V
- 3.0 × 2.41 × 0.8 mm LGA
- Product family approach for varied accuracy levels

Benefits:

- Integrated temperature and humidity sensing solution
- Small form factor solution with lower system cost
- Low power consumption saves battery
- 14-bit high resolution provides extremely tight accuracy
- Insensitive to environmental contaminants like dirt and dust
- Small size solution saves space & BOM for compact designs
- On board calibration reduces time to market
- Wide supply voltage range eliminates the need for LDO/DC-DC

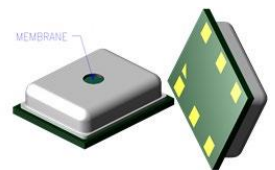
Key applications:

- White goods
- Weather stations & Dew point temperature
- HVAC and air control systems
- Portable and battery operated



Device	Relative Humidity	Temperature
HS3001	$\pm 1.5\%RH$ (Typical), 3.0 × 2.41 × 0.8mm, 6-LGA	-40°C to +125°C
HS3002	$\pm 1.8\%RH$ (Typical), 3.0 × 2.41 × 0.8mm, 6-LGA	-40°C to +125°C
HS3003	$\pm 2.8\%RH$ (Typical), 3.0 × 2.41 × 0.8mm, 6-LGA	-40°C to +125°C
HS3004	$\pm 3.8\%RH$ (Typical), 3.0 × 2.41 × 0.8 mm, 6-LGA	-40°C to +125°C

The HS310x features a hydrophobic membrane protecting it from environmental dusts, particles, and liquids.



Renesas – HS3XXX relative humidity & Temperature sensor

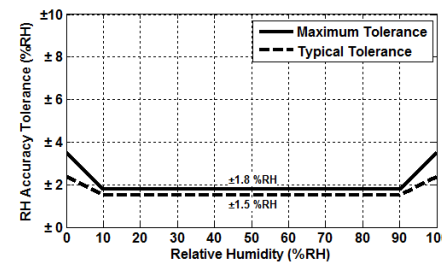
High Accuracy Relative Humidity & Temperature Sensor

Features	Benefits	Applications
<ul style="list-style-type: none"> • $\pm 1.5\%$ relative humidity accuracy (HS3001) • Fast RH response time (Typical 3-6 seconds) • 14-bit resolution, 0.01% RH (Typical) • Low power consumption, 1.0μA average (one RH + T measurement per second) • Temperature sensor accuracy of $\pm 0.2^{\circ}\text{C}$ (HS3001, HS3002) • Extended supply voltage, 1.8 to 5.5 V 	<ul style="list-style-type: none"> • Silicon carbide capacitive sensing element • Excellent stability against aging • Highly robust protection from harsh environmental conditions and mechanical shock • Very low power consumption • Digital I²C output 	<ul style="list-style-type: none"> • Climate control systems • Home appliance • Weather stations • Industrial automation • Process controls and monitoring • Automotive climate control • Medical equipment

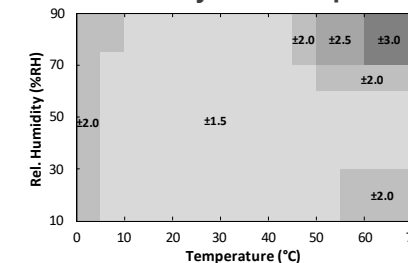
High RH Accuracy and Long Term Stability You Can Depend On



HS3001 Accuracy at 25 ° C



HS3001 Accuracy over Temperature



Renesas – HS400x/HS401x product family

I2C digital output

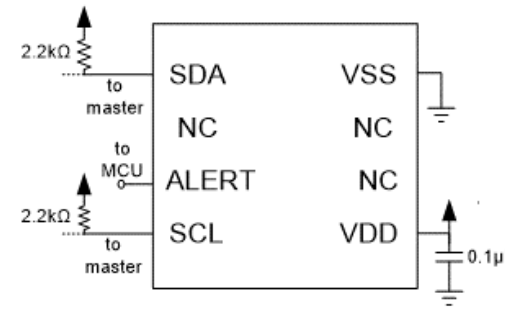
Features:

- Digital I2C output
- $\pm 1.5\%$ RH accuracy (HS4001/HS4011)
- Fast RH response time (Typ. 4 seconds)
- 0.1% RH/Yr drift
- 14-bit resolution: 0.01% RH (Typ.)
- **Low power consumption: 0.62 μ A average**
- Supply voltage: 1.71V to 3.6V
- Operating temperature: **-40°C to +125°C**
- 2.5 x 2.5 x 0.9 mm LGA
- **AECQ-100 qualified**

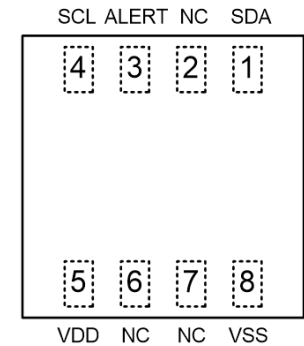
Benefits:

- Integrated temperature and humidity sensing solution
 - o Small form factor solution with lower system cost
- Low power consumption saves battery
- 14-bit high resolution provides extremely tight accuracy
- Small size solution saves space & BOM for compact designs
- Hydrophobic membrane (HS401x), IP67 rated

Application Circuit



Pin-Out Diagram



Device	Relative Humidity Accuracy	Temperature Accuracy
HS4001 HS4011	$\pm 1.5\%$ RH (Typical), 10% to 90% RH	$\pm 0.2^\circ\text{C}$
HS4002 HS4012	$\pm 1.8\%$ RH (Typical), 10% to 90% RH	$\pm 0.2^\circ\text{C}$
HS4003 HS4013	$\pm 2.5\%$ RH (Typical), 20% to 80% RH	$\pm 0.25^\circ\text{C}$
HS4004 HS4014	$\pm 3.5\%$ RH (Typical), 20% to 80% RH	$\pm 0.3^\circ\text{C}$

Competitive Price-to-Performance Value Product Family Choices



Renesas – HS410x/HS411x product family

Analog output

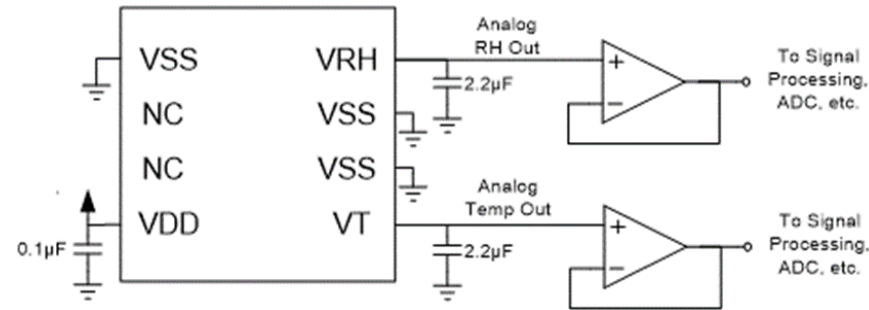
Features:

- **10% to 90% ratio-metric analog output**
- $\pm 1.5\%$ RH accuracy (HS4001/HS4011)
- Fast RH response time (Typ. 4 seconds)
- 0.1% RH/Yr drift
- Low power consumption: 92 μ A average
- Supply voltage: 1.71V to 3.6V
- Operating temperature: **-40°C to +105°C**
- 2.5 x 2.5 x 0.9 mm LGA
- **AECQ-100 qualified**

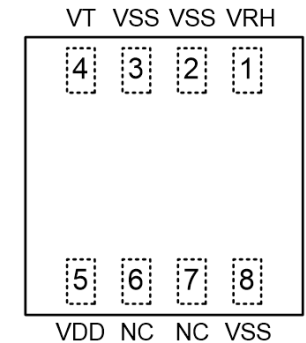
Benefits:

- True Analog output, reduce application components
- Integrated temperature and humidity sensing solution
 - o Small form factor solution with lower system cost
- Low power consumption saves battery
- 14-bit high resolution provides extremely tight accuracy
- Small size solution saves space & BOM for compact designs
- Hydrophobic membrane (HS401x), IP67 rated

Application Circuit



Pin-Out Diagram



Device	Relative Humidity	Temperature
HS4101 HS4111	$\pm 1.5\%$ RH (Typical), 10% to 90% RH	$\pm 0.2^\circ\text{C}$
HS4102 HS4112	$\pm 1.8\%$ RH (Typical), 10% to 90% RH	$\pm 0.2^\circ\text{C}$
HS4103 HS4113	$\pm 2.5\%$ RH (Typical), 20% to 80% RH	$\pm 0.25^\circ\text{C}$
HS4104 HS4114	$\pm 3.5\%$ RH (Typical), 20% to 80% RH	$\pm 0.3^\circ\text{C}$

True Analog Output



Renesas – HS4XXX relative humidity & Temperature sensor

Lowest Power with High Accuracy

Features

- $\pm 1.5\%$ Relative Humidity Accuracy (HS4001, HS4101)
- Fast RH response time (Typical 3 seconds)
- 14-bit resolution, 0.01%RH (Typical)
- Low power consumption, 0.62 μ A average (one RH + T measurement per second, 14-bit)
- Standby current: 25nA
- Temperature sensor accuracy of $\pm 0.2^{\circ}\text{C}$ (HS4001/2, HS4101/2)
- Digital and Analog Output
- Hydrophobic membrane
- Supply voltage, 1.71V to 3.6V
- 2.5 × 2.5 × 0.9 mm, 8-LGA

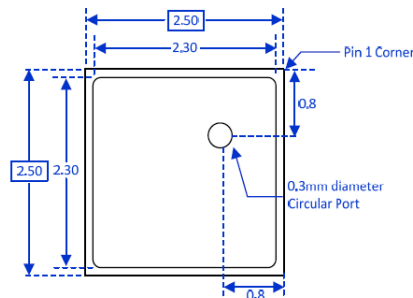
Benefits

- Silicon-carbide capacitive sensing element
- Excellent stability against aging
- Highly robust protection from harsh environmental conditions and mechanical shock
- Very low power consumption
- Digital I²C Output (HS400x)
- Analog Output (HS410x)
- Automotive Qualified, -40°C to +125°C

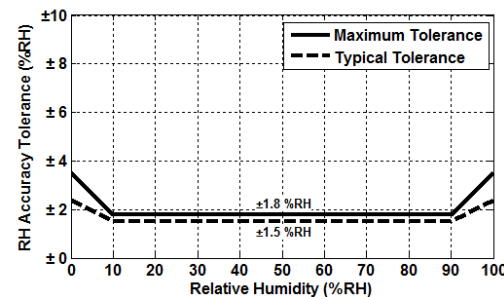
Applications

- Climate control systems
- Home appliance
- Weather stations
- Industrial automation
- Process controls and monitoring
- Automotive climate control
- Medical equipment

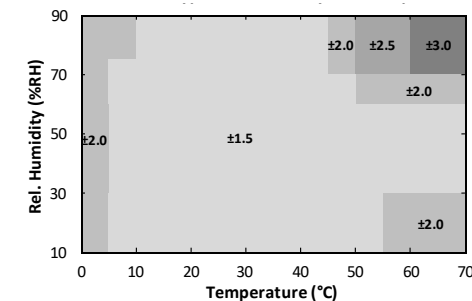
High RH Accuracy and Long-Term Stability You can Depend On



HS4001 Accuracy at 25 ° C



HS4001 Accuracy over Temperature



Sensor technology & key features and benefits

- Industry leading long term stability and reliability

Drift (total): less than **1.25 %RH** over five years, (typical **0.50 %RH** only over five years)

- Fastest in-class response time

Typical **4 seconds** RH time constant in still air

- Best accuracy in the industry

Down to **± 1.5 %RH** accuracy, and **$\pm 0.2^{\circ}\text{C}$** temperature accuracy

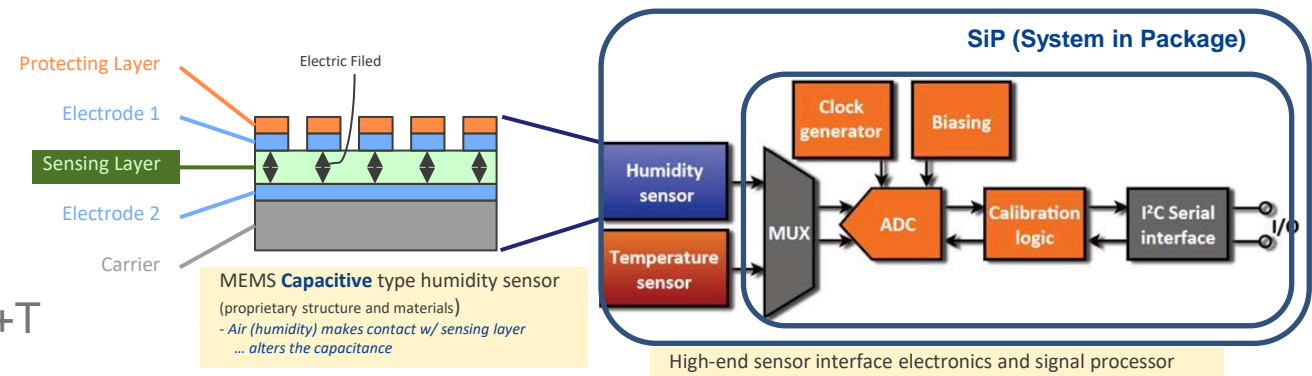
- Micro-Watt level power consumption

Down to **$0.62\mu\text{A}$ average current** at one RH+T measurement per second

- Independent resolution settings for Relative Humidity & Temperature

Resolutions of 8, 10, 12 or 14 bits to increase versatility, and to enable dynamic power consumption management in power-sensitive applications (can trade resolution for power),

Lower resolution means lower power and faster response time



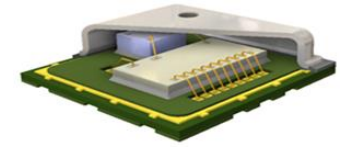
Source

RENESAS



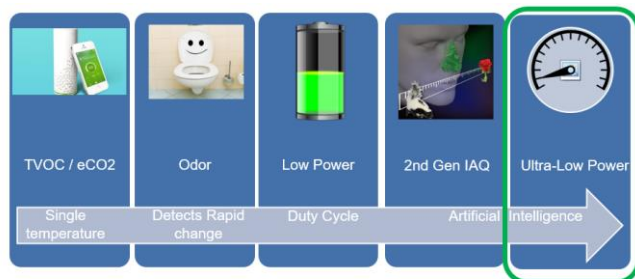
Renesas – ZMOD4410 – Air Quality Sensors

MOX Based Gas Sensor for AIR Quality Measurements - TVOC & eCO2



Features	Benefits	Applications
<p>Application Specific Firmware</p> <ul style="list-style-type: none"> TVOC & eCO2 UBA Calibrated Odor Sensing Sulfur Odor Sensing Ultra Low Power Proven 16+ year history in Mox Siloxane resistant Miniature size: LGA & IP67 waterproof JEDEC qualification – JESD47 Electrical and Gas calibrated 	<ul style="list-style-type: none"> One device & many sensors Reliable and accurate sensors Accepted definition of clean air Part to part consistency Integration into small foot prints Battery operation mode Low cost indication of CO2 Waterproof packages Known 3rd party quality qualification No additional Calibration required 	<ul style="list-style-type: none"> HVAC systems Air purifiers Wireless Access Points Smoke Detectors Smart Thermostats Appliances IoT & IAQ monitors Industrial building controls Smart toilets

FW (AI based) Configurable Gas Sensor



One sensor with multiple software options to support absolute or relative measurements of Indoor Air Quality

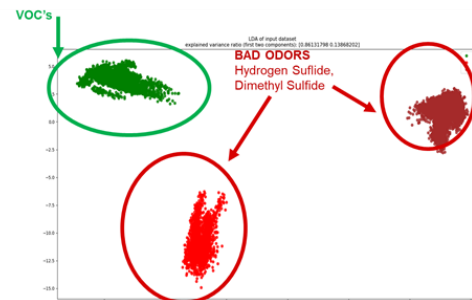
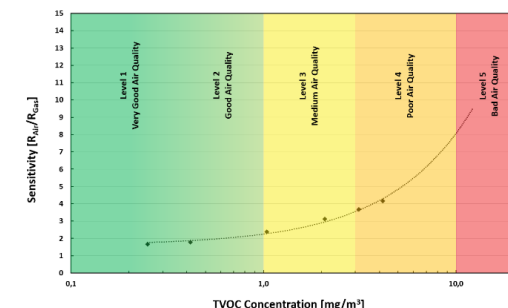
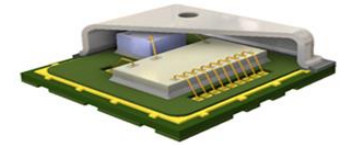


Diagram based on limited laboratory data, for illustrative purposes only.



Renesas – ZMOD4410 Firmware releases



Renesas has pioneered the use of an advanced sensor signal conditioner plus a unique sensing element to develop a series of operating methods that add new features to the ZMOD4410 platform with firmware without changing the hardware.

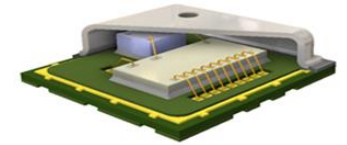
Current Firmware Releases for ZMOD4410

Name of Release	Standard	Application	Target Gases	Sampling Rate	Average Power Consumption	Release
IAQ 2 nd Gen (v3.0): Absolute TVOC for IAQ	UBA	UBA Standard for HVAC air conditioners, air purifiers, thermostats, IAQ monitors	- TVOC: 160 - 10,000 ppb - eCO2: 400 - 5000 ppm	3 sec	6 mW	Released
Relative IAQ	N/A	Control devices for sensing changes in IAQ	Detects a wide range of VOC and VSC and reports changes in air quality	3 sec	6 mW	Released
Sulfur Odor Discrimination	N/A	Bathroom fans and switches	Detects odors (VOC, VSC) and identifies if odor is acceptable (organic) or bad (sulfur)	3 sec	6 mW	Released
IAQ 2 nd Gen: Ultra-Low Power	UBA	UBA Standard for IAQ monitors, rechargeable & portable devices	- TVOC: 160 - 10,000 ppb - eCO2: 400 - 5000 ppm	90 sec	0.16 mW	Released
Relative IAQ: Ultra-Low Power	UBA	Remote & rechargeable devices for sensing changes in IAQ	Detects a wide range of VOC and VSC and reports changes in air quality	90 sec	0.16 mW	Released
IAQ 2 nd Gen: PBAQ	WELL/RESET	WELL Standard for HVAC air conditioners, air purifiers, thermostats, IAQ monitors	- TVOC: 0.5 – 2,000 ppb	5 sec	1 mW	Released



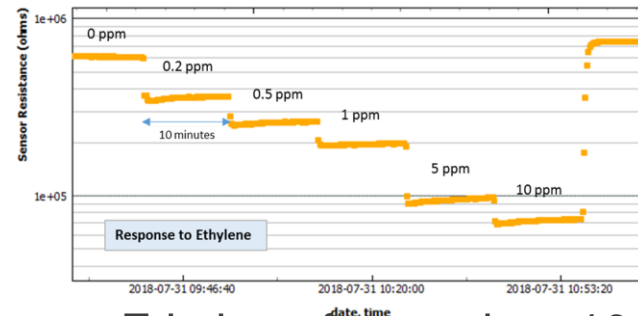
Renesas – ZMOD4450 – Refrigerator Air Quality Sensors

MOX Based Gas Sensor – Supports smart refrigeration systems



Features	Benefits	Applications
<ul style="list-style-type: none"> Targeted refrigerator gasses: <ul style="list-style-type: none"> VSC: Volatile Sulfur gasses Ethylene Proven 16+ year history in MOx production Siloxane resistant Miniature size: LGA & IP67 waterproof JEDEC qualification – JESD47 Electrical and Gas calibrated 	<ul style="list-style-type: none"> Detects Fruit ripening Part to part consistency Integration into small foot prints Waterproof packages Trusted qualification ensuring 10 year life No additional Calibration required 	<ul style="list-style-type: none"> Smart refrigerators Shipping containers Freezer systems Food storage trucking systems Commercial refrigeration

Targeting Food Spoilage and Odors

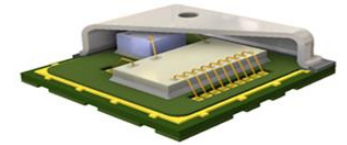


Response to Ethylene from ppb to 10s of ppm



Renesas – ZMOD4510 – O₃ & NO₂ Air Quality Sensors

MOX Based Gas Sensor – Outdoor Air Quality



Features	Benefits	Applications
<ul style="list-style-type: none"> Waterproof package Reliable Detection of Outdoor Air Quality: O₃ & NO_x / Selective O₃ Correlates with US Environmental Protection Agency (EPA) Air Quality Index (AQI) Proven MOx Material, JEDEC JESD47 qualified Electrical and Gas calibrated Miniature 3 x 3 x 0.9mm Digital (I²C) output Siloxane resistant 	<ul style="list-style-type: none"> IP67 rated package Leading high sensitivity and long term stability allows ppb detection limits Smallest sensor in the market enables reduced end product size Allows improved energy efficiency without compromising air quality Enables rapid customer integration with easy to use precompiled software Pre-calibrated sensors save in production costs 	<ul style="list-style-type: none"> Wearables Home & Building automation systems, including HVAC systems Smart fans and damper applications City air monitoring stations Personal monitors Indoor appliances Weather stations

Reporting Calibrated EPA Definition

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	...air quality conditions are:	...as symbolized by this color:
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon



Renesas – RRH46410 - Air Quality + MCU + Firmware

Q3 2023 Release
Prelim datasheet available

Features

- Sensor output based on AI machine learning algorithmic:
 - Absolute measurement of total organic compounds (TVOC) concentrations and indoor air quality (IAQ)
 - Estimated carbon dioxide level (eCO₂)
 - Relative IAQ based on TVOC and odor changes
- Algorithm to discriminate sulfur-based odors
- Ultra-low average power consumption down to 160μW
- Siloxane resistant
- JEDEC JESD47 qualified for 10 years lifetime
- Supply voltage: 1.7V to 3.6V
- Package: 20-LGA
- Dimensions: 4.5 × 4.0 × 0.95 mm body, 0.50 pitch
- Supports I2C and UART

WHY?

- **Accelerate Time to Market**
- **Flexibility to use across all product lines**
- **Improved performance**
- **Reduced Development Costs**



On Board Operation Modes

- IAQ 2nd GEN
- Relative IAQ
- IAQ 2nd GEN ULP
- Relative IAQ ULP
- WELL
- Sulfur Odor



Renesas – RRH62000 – All-in-one integrated sensor module

Q3 2023 Release

Prelim datasheet available

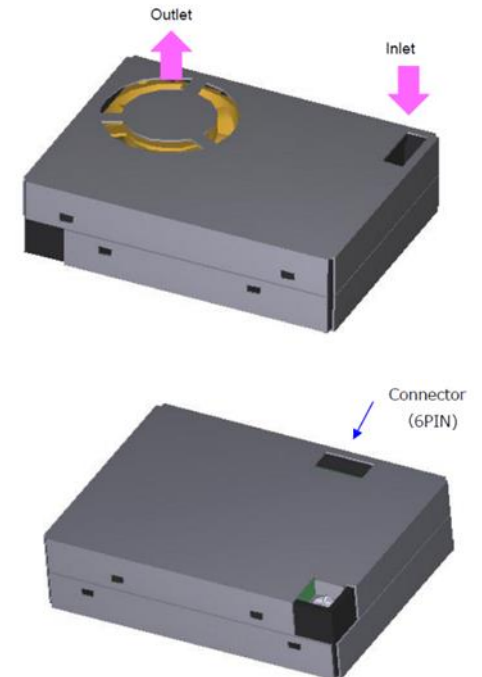
Features

Simultaneous multi-sensor measurements of all relevant air quality parameters

- Up to nine sensor outputs:
 - **Particulate Matter**
 - Detection of particle sizes from 0.3µm to 10.0µm
 - Output mass concentration bins for PM1, PM2.5, and PM10
 - Laser based PM2.5 detection
 - **Temperature and Humidity**
 - Operating temperature range up to 60°C
 - Operating humidity range up to 90% RH
 - Temperature sensor accuracy: ±0.2°C
 - **TVOC and Indoor Air Quality**
 - TVOC concentrations and indoor air quality (IAQ) index according to UBA
 - Estimates carbon dioxide level (eCO2)
 - Siloxane resistant
- Targeted - JEDEC JESD47 qualification
- Targeted - Standards Based Output : WELL, RESET
- I2C interface
- Outline dimensions 46.6 × 34.8 × 12 mm
- 77 Module Lifetime : 50,000 hours

Applications

- Air Purifiers
- Smart Home Appliances
- Air Quality Monitors
- HVAC / Demand Control Ventilation
- IoT Devices



NPI specs subject to change



Renesas – Air velocity sensor

Surface mount air velocity module

Features	Benefits	Applications
<ul style="list-style-type: none"> Thermal mass air flow measurement principle Fully calibrated Robust Isolation technology resistant to surface contamination Resistant to vibration and shock I2C output Module size – 8 x 9 x 3.7 mm 	<ul style="list-style-type: none"> No long term drift Output calibrated in meter/second Two variants available 0-7.23m/s and 0-15m/sec “solid” thermal isolation technology and silicon-carbide coating to protect it from abrasive wear and water Accuracy - +/-5% of Full scale 	<ul style="list-style-type: none"> Breath analyzers Data center and servers HVAC and air control systems Laminar flow control systems Air filtration and collection systems

FS3000 air velocity module



Renesas – RTD60/RTD120 – Silicon-Based Thermopile Detector

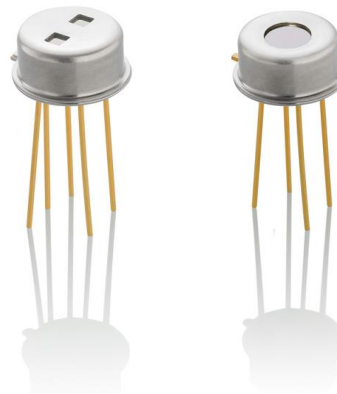
Industry's best Thermopile performance, quality and longevity

Applications

- Gas analysis
- Fire suppression
- Non-contact temperature sensors
- Horizon sensors
- Industrial/environmental leak detection
- Air quality monitoring
- Capnography

Feature Rich

- Very low time constant
- Nitrogen encapsulation gas
- Internal 5% NTC chip thermistor provides ambient package temperature measurement
- Internal aperture precisely defines active area for applications with FOV and/or spot size requirements

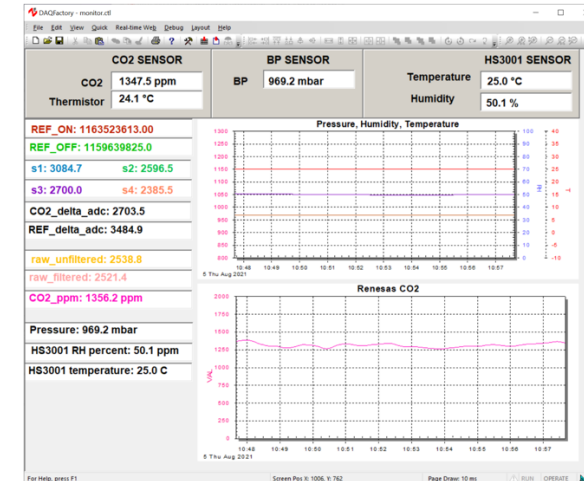
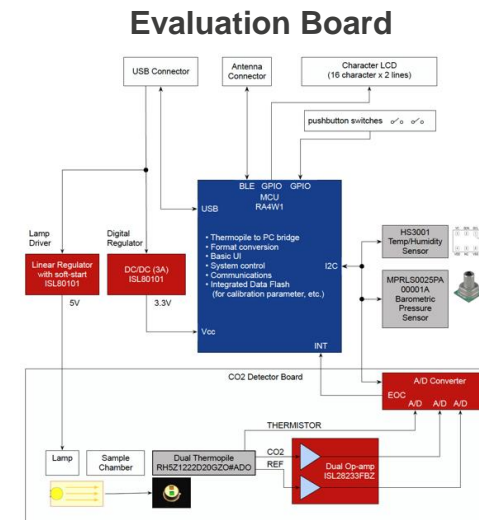


Dual

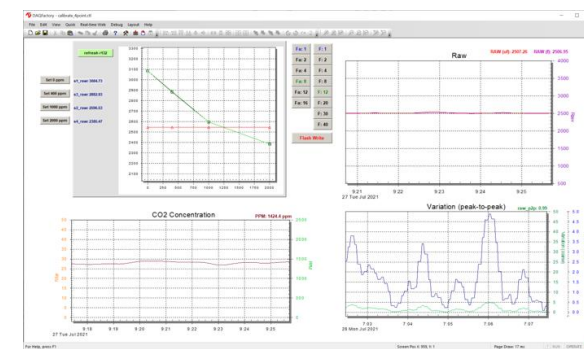
Single



Part #	# of elements	Package	Features
RH5Z0610D20GZO	Single	Four pin TO-5	small active area
RH5Z1210D20GZO	Dual	Five pin TO-5	small active area,
RH5Z0622D20GZO	Single	Four pin TO-5	high sensitivity, high output
RH5Z1222D20GZO	Dual	Five pin TO-5	high sensitivity, high output



EVK GUI Software



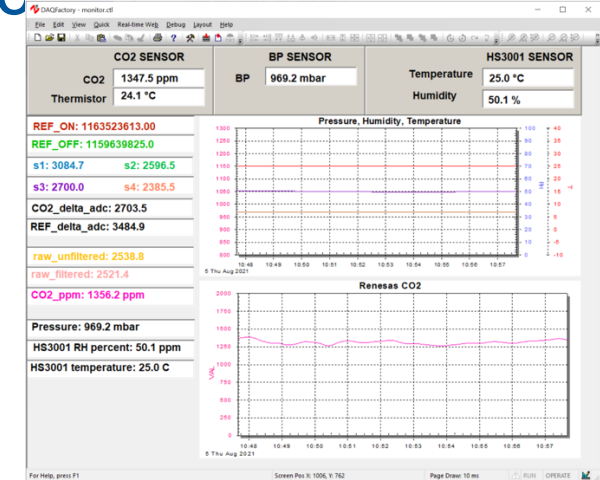
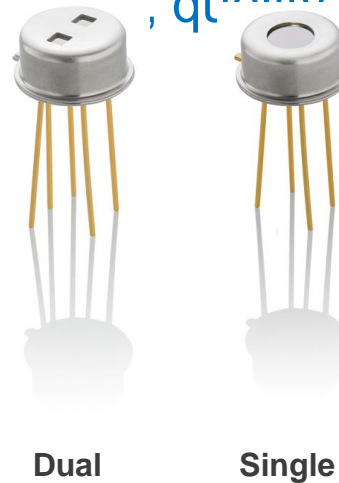
RTD60/RTD120 – Silicon-Based Thermopile Detector

Applications

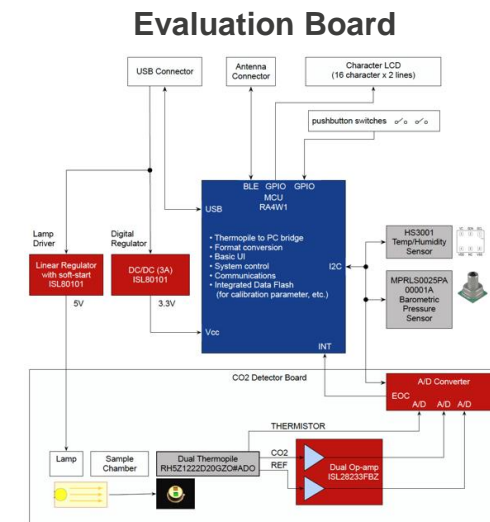
- Gas analysis
- Fire suppression
- Non-contact temperature sensors
- Horizon sensors
- Industrial/environmental leak detection
- Air quality monitoring
- Capnography

Feature Rich

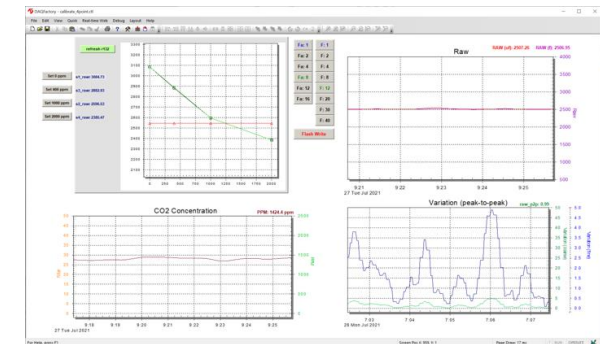
- Very low time constant
- Nitrogen encapsulation gas
- Internal 5% NTC chip thermistor provides ambient package temperature measurement
- Internal aperture precisely defines active area for applications with FOV and/or spot size requirements



Part #	# of elements	Package	Features
RH5Z0610D20GZO	Single	Four pin TO-5	small active area
RH5Z1210D20GZO	Dual	Five pin TO-5	small active area,
RH5Z0622D20GZO	Single	Four pin TO-5	high sensitivity, high output
RH5Z1222D20GZO	Dual	Five pin TO-5	high sensitivity, high output



EVK GUI Software



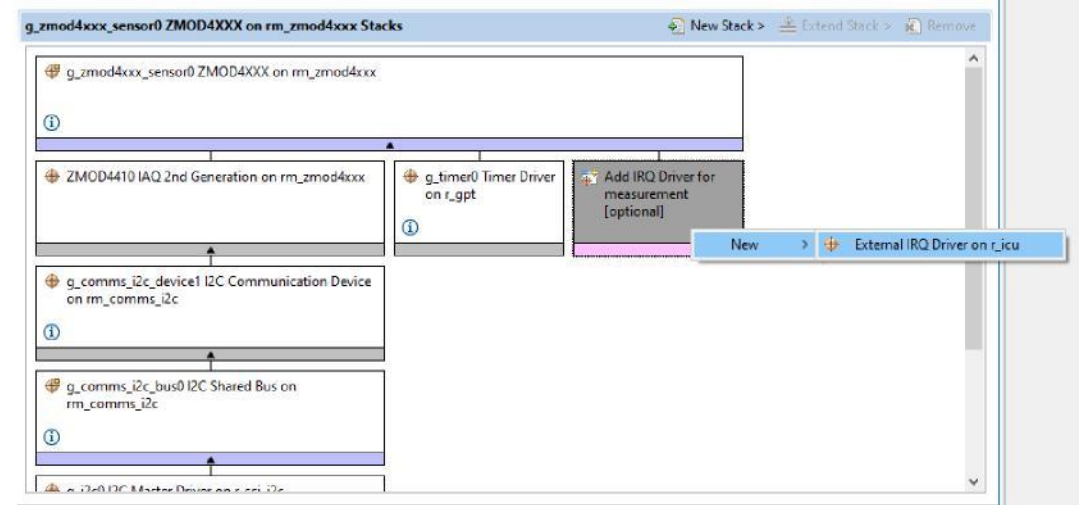
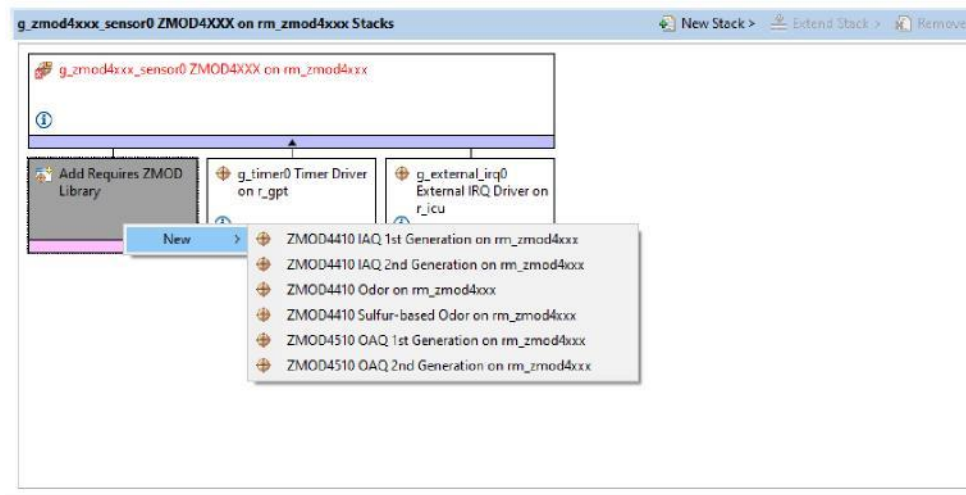
Renesas – Sensors API – an overview

- The sensors API are modules in the FSP which provide an API which communicates with a set of sensors.
- There currently exists two sensor APIs:
 - HS300x
 - ZMOD4xxxx
- Both APIs make use of the **I2C Device** module, which uses the **I2C Bus** module.
- Within each sensor module, we can configure which sensor within the sensor family is being communicated with (supported sensors detailed later in presentation – Page 20).
- The sensors modules describe the sensor in software and provide an interface which breaks-out the functionality of the sensor, thus abstracting us away from the I2C Device.
- [Documentation for the Sensors API can be found in the FSP documentation available on the Github page: RA Flexible Software Package Documentation: Introduction \(renesas.github.io\)](#)



Renesas – Sensors API – ZMOD4XXX

- The ZMOD4xxx module allows us to select which sensor we are communicating with and what information we are requesting from it through the FSP Configurator.
- By selecting which library, we want to use, this determines which device we are communicating with and what post processing should be done on the data retrieved.
- Another option is to whether to include the IRQ driver which is used internally, either to;
- Monitor the BUSY signal.
- Or accept the INT signal.



ScioSense



ScioSense – Environmental Sensing Portfolio

Production

Development

Planned

(A) Automotive grade

ENS215

RH+T Digital Sensor

(A)

ENS170A

Automotive multi-gas AQ digital sensor

(A)

BCM1

Battery Condition Monitor, LIN

(A)

ENS213A

RH+T Digital Sensor
AEC Q100 grade 1

ENS161

Digital Air Quality sensor
(multi gas, low power)

(A)

DPS1

HVAC Dewpoint Sensor, RHT, LIN

ENS211/212

RH+T Digital Sensor

ENS160

Digital Air Quality sensor
(multi gas)

(A)

ACM4

Air Class' module
3 channels, RHT, LIN

(A)

ENS210/210A

RH+T Digital Sensor
AEC Q100 grade 1

(A)

ENS145 / 145A

Analog Multi-gas sensor

ENS220

Digital relative and absolute Pressure Sensor

APC1

PM+VOC+RHT Module

(A)

ACM3

Air Class' module, PWM

Temp. + Humidity

Gas & Air Quality

Pressure

Combos

Automotive Modules



ScioSense – ENS210

Digital Relative Humidity & Temperature sensor

Features

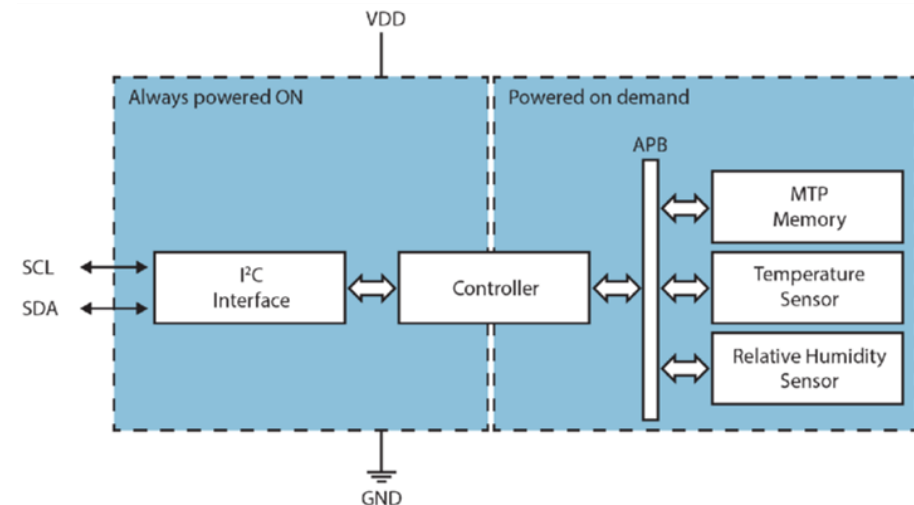
- Typical accuracy:
 - Temperature: $\pm 0.15^{\circ}\text{C}$ (0°C to 70°C)
 - Relative humidity: $\pm 2.0\%$ RH (0°C to 85% RH)
- Wide operating range: 0% to 100% RH and -40°C to 105°C
- Digital precalibrated output in K and %RH
- Supply voltage range: 1.71V to 3.60V
- Stand by current 40nA , Active current $6.6\mu\text{A}$ @ 1Hz (1.8V)
- Low drift: 0.25% RH p.a.
- Fast response time: $T < 1\text{s}$, RH $< 3\text{s}$
- Interface: I2C standard (100kbit/s) and fast (400kbit/s)
- Package: open cavity QFN $2.0 \times 2.0 \times 0.75\text{mm}$

Benefits

- Highest accuracy in broad operating range
- Ultra low power, High reliability
- Fast response, Small footprint
- AEC-Q100 grade 2 qualified (grade 1 in Q1/2022)
- NIST traceable
- Alternative I2C address available (ENS210C)

Applications

- Building Automation / Smart home / HVAC
 - Demand controlled ventilation
 - Smart thermostats
- Home appliances
 - Air cleaners / purifiers
 - Refrigerators, washing machines, dishwashers, dryers
- Mobiles / Wearables / IoT devices
- Portable devices for personal health and wellness
- Weather stations

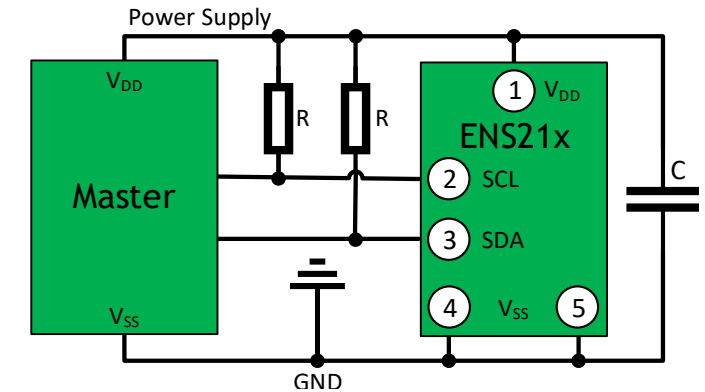


ScioSense – ENS21x family

High-performance digital temperature and humidity sensors

Multi-Industry solutions

- Building automation / HVAC / Home appliances
- Condition monitoring / Cold-chain management
- IoT devices & wearables
- Instrumentation
- Automotive



Industry leading accuracies

1. Temperature accuracy down to $\pm 0.1^{\circ}\text{C}$
2. Humidity accuracy down to $\pm 0.8\%$
3. Fast response times: $<1\text{s}$ (T); $<3\text{s}$ (RH)
4. Ultra low-power: 40nA stand-by current

Properties

- 2.0 x 2.0 x 0.75mm QFN4 package
- Operating voltage range : 1.71 – 3.6V
- Standard I2C digital interface
- AEC Q100 grade 1 variants available
- Topp: -40 – 125°C, RHopp: 0 – 100%

Sensor	Application	T-accuracy*	RH-accuracy*
ENS210A	Automotive qualified	$\pm 0.15^{\circ}\text{C}$	2.0%RH
ENS211	Consumer and appliances	$\pm 0.15^{\circ}\text{C}$	2.0%RH
ENS212	Premium consumer and appliances	$\pm 0.15^{\circ}\text{C}$	1.5%RH
ENS213A	Premium accuracies at high humidity	$\pm 0.15^{\circ}\text{C}$	1.0%RH
ENS215	Peak performance for instrumentation	$\pm 0.10^{\circ}\text{C}$	0.8%RH

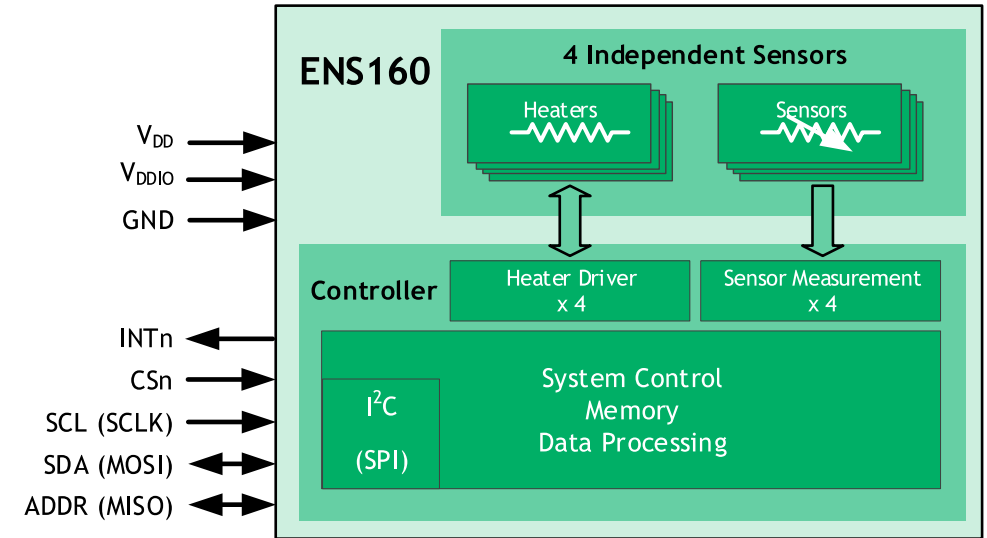


SciSense – ENS160

Digital Metal Oxide Multi-Gas Sensor

Features

- Multiple IAQ outputs (TVOC, eCO₂, AQI)
- <5 minutes warm-up
- **True siloxane immunity**
- Hassle-free all-on-chip data processing
- Wide operating range & separate VDDIO
- Small 3.0 x 3.0 x 0.9mm LGA package
- High-speed I²C and SPI
- Low peripheral BOM required
- Tape & reel, reflow solderable
- Environment: –40 to +85°C / 5 to 95% rH
- VCC: 1.71 – 1.98V, VDDIO: up to 3.6V

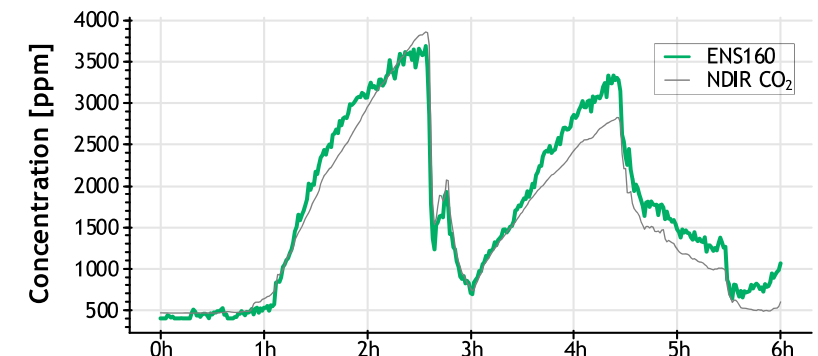


Benefits

- Freedom of air quality signal choice
- Crucial for quick system start-ups
- Safe use with everyday products
- **No libraries needed** – no host CPU impacts
- Allowing for flexible & rugged designs

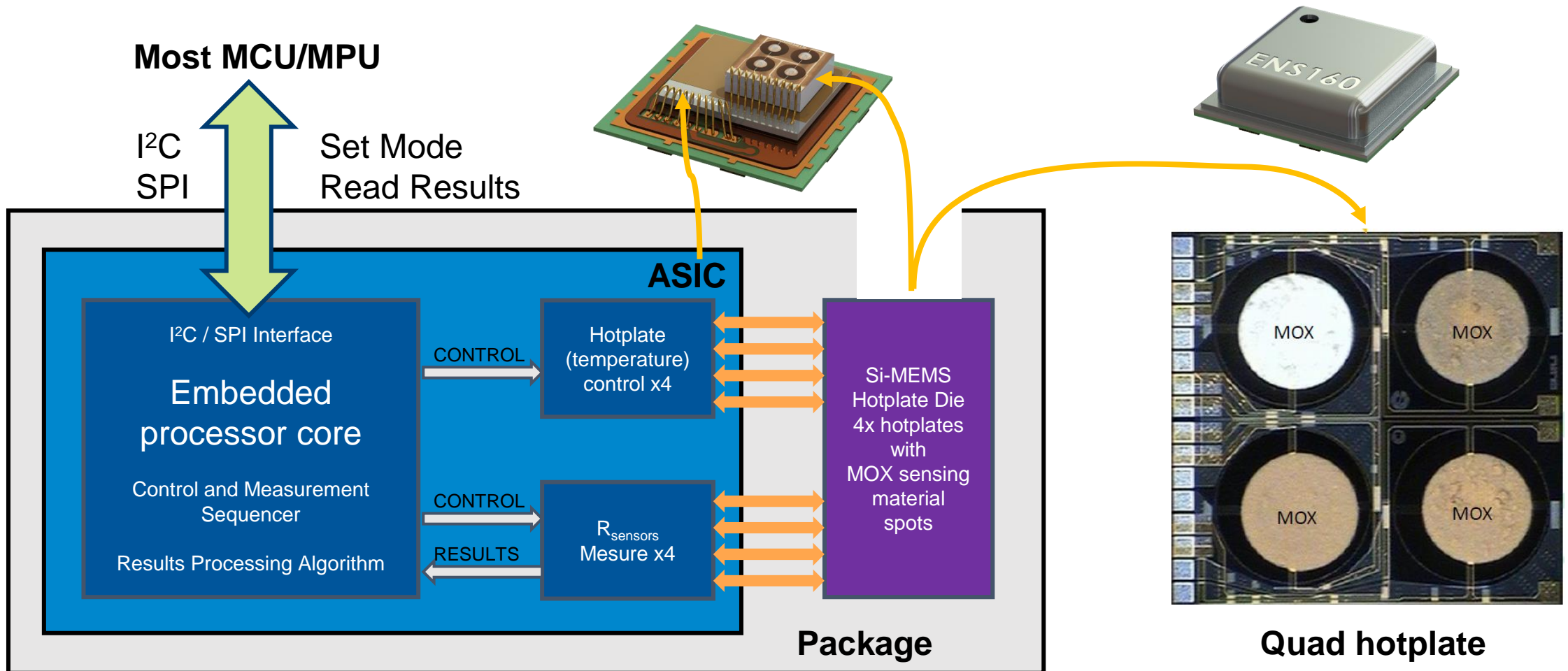
Applications

- Air purification / home automation
- HVAC / ventilation systems
- Building automation / smart thermostats
- Appliances / cooker hoods
- Mobiles / wearables
- Smart things & IoT devices



SciSense – ENS160

Architecture

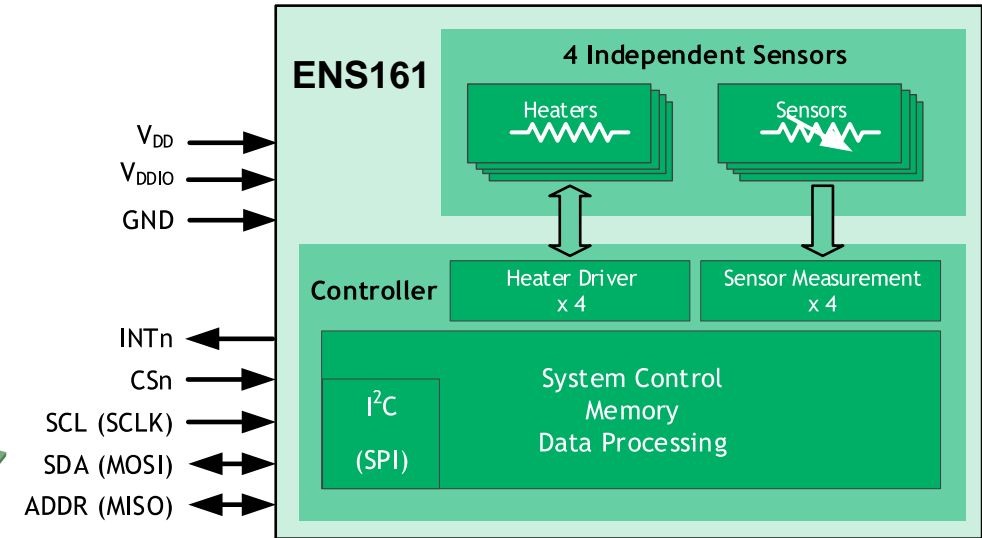
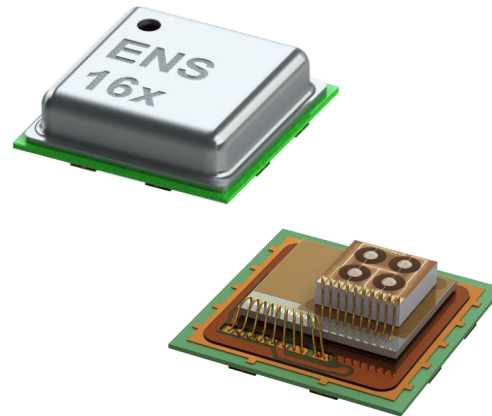


ScioSense – ENS161

Low Power Digital Metal Oxide Multi-Gas Sensor

Features

- **Low power** operating modes down to **150µA**
- **Multiple IAQ outputs (TVOC, eCO2, AQI)**
- <5 minutes warm-up
- **True siloxane immunity**
- Hassle-free all-on-chip data processing
- Wide operating range & separate VDDIO
- Small 3.0 x 3.0 x 0.9mm LGA package
- High-speed I²C and SPI
- Low peripheral BOM required
- Tape & reel, reflow solderable
- Environment: –40 to +85°C / 5 to 95% rH
- VCC: 1.71 – 1.98V, VDDIO: up to 3.6V



Benefits

- Freedom of air quality signal choice
- Crucial for quick system start-ups
- Safe use with everyday products
- **No libraries needed** – no host CPU impacts
- Allowing for flexible & rugged designs

Applications

- Air purification / home automation
- HVAC / ventilation systems
- Building automation / smart thermostats
- Appliances / cooker hoods
- Mobiles / **wearables**
- Smart things & IoT devices

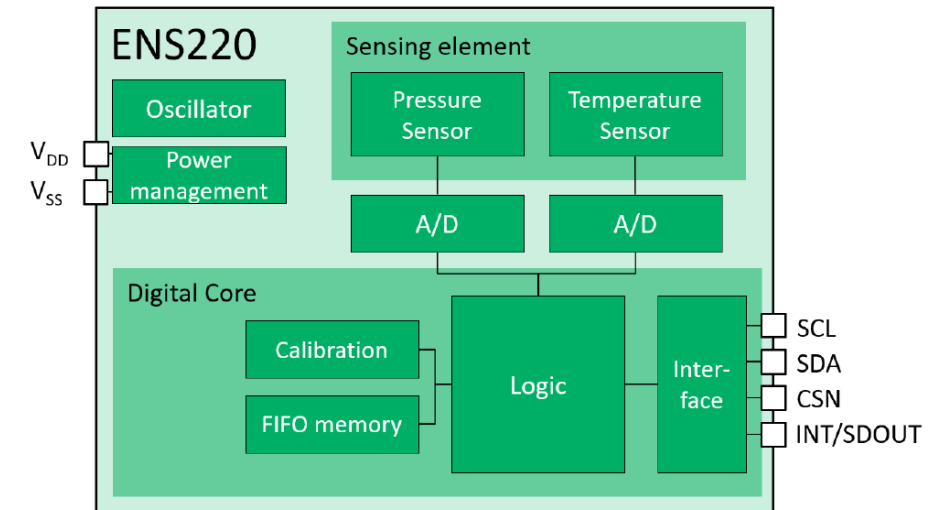


ScioSense – ENS220

Premium accuracy barometric pressure and temperature sensor

Features

- P operating range from 300 to 1200 hPa
- T operating range from -40 to +85 °C
- Absolute / Relative accuracy: ± 0.5 hPa / ± 0.025 hPa (equiv. to ± 20 cm in air)
- Lowest power: average supply current of 100nA (idle), 800nA (1/60 Hz)
- Ultra-low noise of 0.1 Pa rms (≈ 1 cm in air) at 2 Hz sample rate
- User-configurable sample rate up to 1 kHz (0.9 Pa rms)
- Temperature accuracy of 0.2 K with 8 mK resolution
- Fully digital interface with best-of-breed form factor
- Small 2.0 x 2.0 x 0.75 mm LGA package
- Power supply range from 1.62 V to 1.98 V
- Standard, fast, and high speed I2C and SPI interface



Benefits

- Reliable cm resolution positioning and differential pressure measurements
- Perfectly integrates into space-constraint designs, e.g. mobiles, wearables, hearables
- Long battery life even at high sampling rates
- Minimal peripheral BOM requirements

Applications

- Mobile/Wearables: activity tracking, indoor localization/navigation, fall detection
- Gaming, AR/VR, Drones: height tracking
- Appliances/HVAC: filter clogging detection
- White goods: liquid level detection
- Medical: blood pressure measurement
- Accurate temperature meter for gasses and surfaces



ScioSense – APC1

Air Quality Combo Sensor

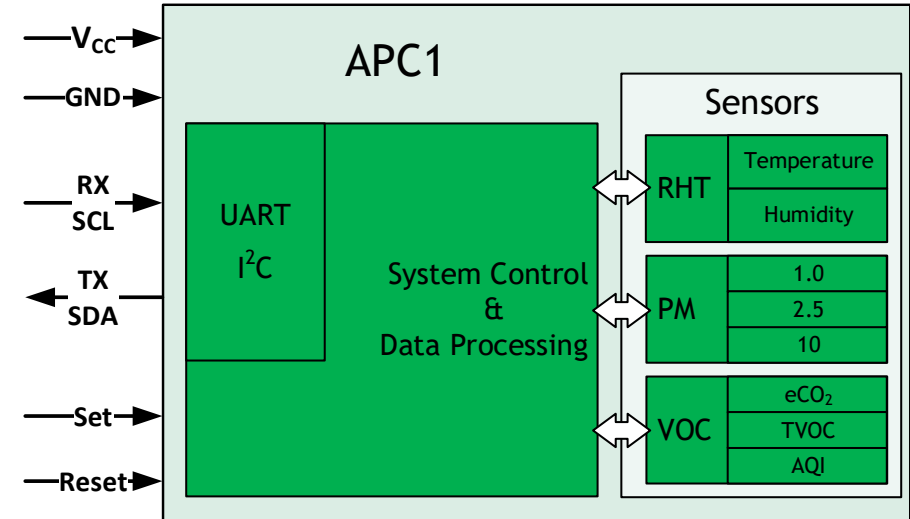
- Particle: PM1.0, PM2.5 & PM10,
- TVOC, eCO2 & AQI
- Temperature & relative humidity

Features

- Up to 20 calibrated signal outputs:
- PM1.0, PM2.5, PM10, TVOC, eCO2, AQI, temperature and relative humidity
- Matchbox-size, fully orchestrated design
- Particle detection down to 0.3µm
- Superior accuracies over wide temperature and humidity ranges (self-compensated)

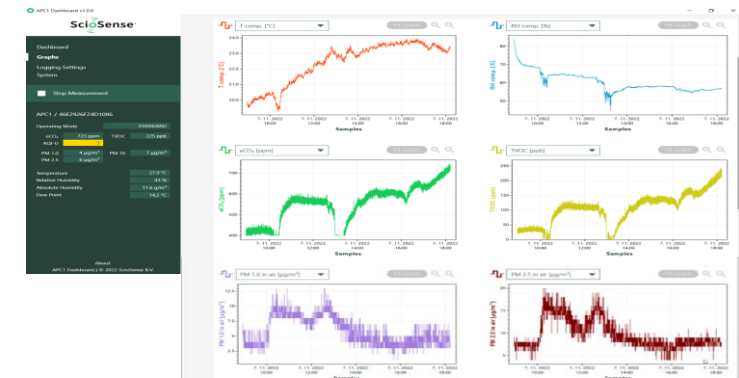
Benefits

- All-in-one air quality module, easy integration
- Self-compensated, best temperature and humidity accuracy in the market
- Compliant with international standards
- Smallest form factor



Applications

- Home appliances
 - Air cleaners / purifiers
- Building automation / smart home / HVAC
 - Indoor air quality detection
 - Demand-controlled ventilation
- Smart thermostats
- IoT devices & air quality monitors



SciSense – AS3935 Franklin Lightning Sensor™ IC

Lightning sensor IC with embedded distance estimation algorithm

Features

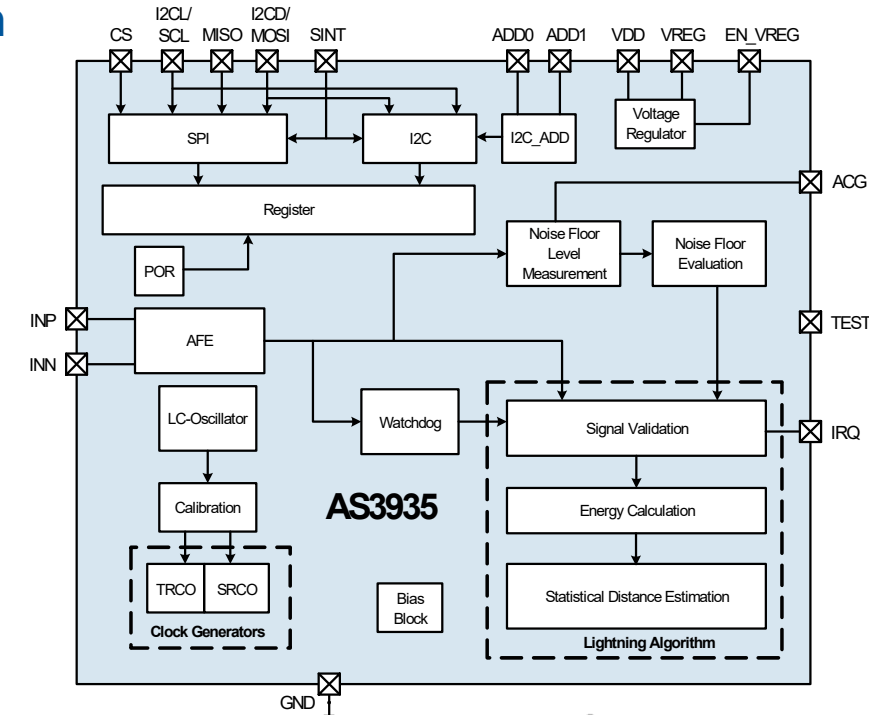
- Detection of both cloud to ground and cloud to cloud lightning activity within a 40km range
- Intelligent algorithm provides for false disturber rejection
- Supply voltage range of 2.4-5.5V with power down, listening and active power modes (1/60/350uA)
- Antenna auto tuning
- Small MLPW-16 (4mmx4mm) package

Benefits

- All-in-one air quality module, easy integration
- Self-compensated, best temperature and humidity accuracy in the market
- Compliant with international standards
- Smallest form factor

Applications

- Watches, Key chains, Portable GPS, Bike computers, Sports equipment
- Golf carts
- Weather stations
- Uninterruptible power supply
- Power line conditioners
- Smart grid systems
- Environmental monitoring systems



Demo Kit



STMicroelectronics



STM – Temperature sensors portfolio

Digital output

- **Programmable** temp. conversion rate.
- **One-shot reading** for current saving.
- Pin for **interrupt generation** with programmable threshold & hysteresis.

- **Accuracy flat** (typ) across the whole operating range.
- **I²C/SMBus** output with selectable address (up to 8).
- **One-shot reading** for current saving.
- Dedicated pin for interrupt or **thermostat/comparator** function
- Programmable threshold with hysteresis.

Pin-to-pin compatible with Texas Instruments, Microchip and Maxim part numbers

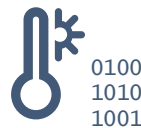
STTS751



Temp. range: -40°C / +125°C
Accuracy (typ/max):
 $\pm 1.0^{\circ}\text{C}$ @25°C / $\pm 2.5^{\circ}\text{C}$ @125°C
V_{CC}: 2.25 V – 3.6 V
I_{DD}: 20 μA (typ @ 1 conv/s)
Resolution: prg 9 – 12 bit
Conversion time: 14 – 112ms (max)
 UDFN-6L (1.0 x 1.3 x 0.5mm)

I²C/SMBus 2.0 output. Up to 8 selectable addresses

STCN75



Resolution: 9 bit
Conversion time: 85 ms (max)
I_{DD}: 125 μA (typ)
 MSOP-8 (3.0 x 3.0 x 1.1mm)



STLM75



Resolution: 9 bit
Conversion time: 150 ms (max)
I_{DD}: 125 μA (typ)
 MSOP-8 (3.0 x 3.0 x 1.1mm)
 SO-8 (4.9 x 3.9 x 1.75mm)



STTS22H



Temp. range: -40°C / +125°C
Accuracy: $\pm 0.5^{\circ}\text{C}$ from -10°C to 60°C (max)
V_{CC}: 1.5 V – 3.6 V
I_{DD}: 1.7 μA in, one-shot mode
 UDFN (2.0 x 2.0 x 0.5mm)



I²C/SMBus 3.0 output with ALERT (ARA) support

STTS75



Resolution: prg 9 – 12 bit
Conversion time: 85 – 680 ms (max)
I_{DD}: 75 μA (typ)
 MSOP-8 (3.0 x 3.0 x 1.1mm)
 SO-8 (4.9 x 3.9 x 1.75mm)



STDS75



Resolution: prg 9 – 12 bit
Conversion time: 150 – 1200 ms (max)
I_{DD}: 125 μA (typ)
 MSOP-8 (3.0 x 3.0 x 1.1mm)

COMMON FEATURES:

V_{CC}: 2.7 V - 5.5 V – **Temp. range:** -55°C / +125°C – **Accuracy:** $\pm 0.5^{\circ}\text{C}$ (typ), $\pm 3.0^{\circ}\text{C}$ (max)





STM – Temperature sensors portfolio

Analog output

- Very low current consumption.
- Predictable curvature error
- **Suitable for:** consumer, portable, industrial and medical applications, home appliances.

Pin-to-pin compatible with Texas Instruments part numbers

- Accuracy flat across the whole operating range.
- Up to 200°C operating temp. (non continuous).
- **Suitable for:** Industrial applications & home appliances

Pin-to-pin compatible with Texas Instruments part numbers



STLM20DD9F
Temp. range: -40°C / +85°C
Accuracy (typ/max): ±0.5°C @25°C / ±1.0°C @85°C
 V_{CC} : 2.4 V – 5.5 V
 I_Q : 4.8 µA
UDFN-4L (1.0 x 1.3 x 0.5mm)



STLM20W87F
Temp. range: -55°C / +130°C
Accuracy (typ/max): ±0.5°C @25°C / ±1.5°C @130°C
 V_{CC} : 2.4 V – 5.5 V
 I_Q : 4.8 µA
SOT323-5L (1.8 x 1.15 x 0.8mm)



LM335
Temp. range: -40°C / +100°C
Accuracy (typ/max): ±0.5°C / ±1.0°C
 I_R : 450µA to 5mA
To-92 (3.7 x 5.03mm)
SO-8 (4.8 x 3.9 x 1.75mm)



LM235
Temp. range: -40°C / +120°C
Accuracy (typ/max): ±0.5°C / ±1.5°C
 I_R : 450µA to 5mA
To-92 (3.7 x 5.03mm)
SO-8 (4.8 x 3.9 x 1.75mm)



LM135
Temp. range: -55°C / +150°C
Accuracy (typ/max): ±0.5°C / ±1.5°C
 I_R : 450µA to 5mA
To-92 (3.7 x 5.03mm)
SO-8 (4.8 x 3.9 x 1.75mm)





STM – STTS22H Temperature sensor

Integrated ultra-low power, high accuracy temperature sensor

STTS22H 2x2 6-lead UDFN



Exposed pad down for better temperature matching with external environment

Specifications

- Range: -40°C to +125°C
- Accuracy:
 - ±0.25°C Typ [-10°C : 60°C]
 - ±0.5°C Max [-10°C : 60°C]
 - ±1.0°C Max [-40°C : 125°C]

Features / Benefits

- **NIST Certification by Q3'20**
- Industry standard package
- Output interface I2C/SMBus 3.0
- One-shot mode for power saving (1.75 µA)
- Factory calibrated

Applications

- Wearable devices
- Portable devices
- Smartphones
- Home appliances
- Asset and goods tracking
- Predictive Maintenance



Evaluation Tools

STEVAL-MKI200V1K (DIL24)
STEVAL-MKIGIBV1 adapter



+

STEVAL-MKI109V3
(Profi MEMS)



+

Unico GUI graphical user interface



STM – LIS2DTW12 Temperature + accelerometer

Ultra low power / Low noise accelerometer with temperature Sensor

LIS2DTW12 2x2x0.7 LGA12



Specifications

Main parameters:

- **Supply voltage from 1.62V to 3.6V**
- **Operating temperature from -40°C to +85°C**
- **Temp Accuracy:**
 - $\pm 0.8^{\circ}\text{C}$ Typ [0°C : 70°C]
 - $\pm 1.3^{\circ}\text{C}$ Typ [-40°C : 85°C]

Features / Benefits

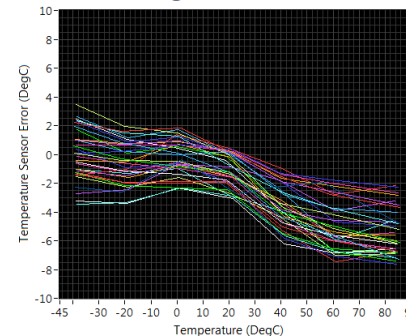
- A high performance 3-axis accelerometer
- Up to 16g full scale, ODR from 1.6 Hz up to 1.6 kHz
- Multiple low-power and low-noise settings
- FIFO, LP and HP filters, Self-Test

Applications

- Fragile shipment tracking
- Motion and temperature monitoring in battery-powered devices
- Smart power saving for handheld devices
- Portable healthcare devices

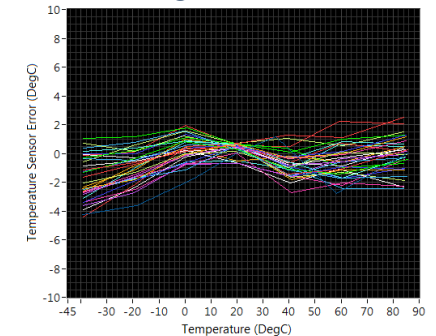
- Factory calibration ensure an homogeneous accuracy within the whole operating temp range
- Further improvement can be met with an additional OPC at customer production line

LIS2DW12



Factory Calibration

LIS2DTW12

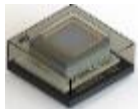


STMicroelectronics – Pressure sensors roadmap

Main products

Ambient pressure sensors

LPS22HB



2 x 2 x 0.76 mm

Full molded PKG with 6 vent holes
Absolute accuracy = ± 1 hPa (0~65°C)
Noise RMS [HP] = 0.75 Pa

LPS22HH



2 x 2 x 0.73 mm

High performance with full-molded PKG
Absolute accuracy = ± 0.5 hPa (-20~80°C)
Noise RMS [HP] = 0.65 Pa

LPS22DF



2 x 2 x 0.73 mm

Ultra low power & high performance
Absolute accuracy = ± 0.5 h Pa (-20~80°C)
Power consumption =
1.7 uA [ULP] / 9.4 uA [HP]

ILPS22QS



2 x 2 x 0.73 mm

1st barometer with embedded Qvar
Industrial pressure sensor
Operating T : -40 ~ 105°C
Pressure FS : Up to 4 Bar



Performance improvement & smaller PKG

Liquid resistant pressure sensors

LPS33HW



3.3 x 3.3 x 2.9 mm

Waterproof package (3x3 mm)
Noise RMS [HP] = 0.8 Pa
Absolute accuracy = ± 2.5 hPa (0~65°C)
Relative accuracy = ± 0.1 hPa (800~1100hPa)
LPS33K : Pin to Pin with MS5837

LPS33W



3.3 x 3.3 x 2.9 mm

LPS33K



3.3 x 3.3 x 2.9 mm

LPS27HHW



2.7 x 2.7 x 1.7 mm

LPS27HHTW

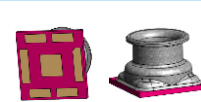


2.7 x 2.7 x 1.7 mm

Waterproof package (2.7x2.7mm)
Noise RMS [HP] = 0.7 Pa
Absolute accuracy = ± 1 hPa (0~65°C)
ESD robustness
LPS27HHTW : Embedded temperature ($\pm 1.5^\circ\text{C}$ @ 25~65°C)



LPS28DFW



2.8 x 2.8 x 1.95 mm

Wider dual full scale & lower power (w/ Qvar)
Dual FS : ~ 1.26Bar / ~ 4 Bar
Power consumption : 1.7 uA [ULP] / 9.4 uA[HP]
Noise RMS [UHP] = 0.32 Pa
Embedded temperature 1.5°C
ESD robustness
Robustness PKG to mechanical stress

ILPS28QSW



2.8 x 2.8 x 1.95 mm

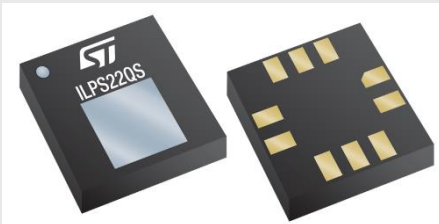




STMicroelectronics – ILPS22QS

Industrial pressure sensor with full molded package

Wide full scale up to 4060 hPa with dual scale mode and wide operating temperature



LPS22HH

High performance barometer

- Absolute accuracy = $\pm 0.5\text{hPa}$ (-20~80°C)
- Noise RMS [HP] = 0.65Pa
- Power consumption: 4uA [ULP] / 12uA [HP]
- ODR = up to 200Hz
- TCO = 0.65Pa/°C @ -20~65°C

Evolution

**Common full molded package
2x2x0.73 mm**

ILPS22QS key features

- **Dual FS mode**
 - **Mode 1:** up to 1260 hPa (1.26Bar) / **Mode 2:** up to 4060 hPa (4Bar)
- **High accuracy and resolution:**
 - Absolute pressure **accuracy** 0.5 hPa (Mode 1) / 0.28% (mode 2)
 - **Low noise** 0.34 Pa (Mode 1) / 0.57 Pa (Mode 2)
- **Current consumption** down to 1.8uA [ULP] / 9.2uA [HP]
- **Embedded temperature compensation**
- **High performance TCO** 0.45 Pa/°C (temperature coefficient offset)
- 2 times OPC writing available on dedicated OTP
- 8 different **ODR support from 1 Hz to 200 Hz.**
- FIFO: 128 samples only pressure
- **Qvar sensor embedded**
- **Unique full molded package** 2x2x0.73 mm – to offer smallest size and superior robustness
- **Extended operating temperature:** -40°C **+105°C**





STMicroelectronics – ILPS22QSW

Industrial pressure sensor with waterproof package

Enable wide full scale up to 4060 hPa with dual scale mode & ultralow power consumption



LPS27HHW

Smallest WP pressure sensor

- FS: ~ 1260 hPa
- Noise RMS [HP] = 0.7Pa
- Absolute accuracy = ± 1 hPa (0~65°C)
- Power consumption: 4uA [ULP] / 12uA [HP]
- Superior robustness to ESD
- CLGA 2.7x2.7x1.7 mm3

Evolution

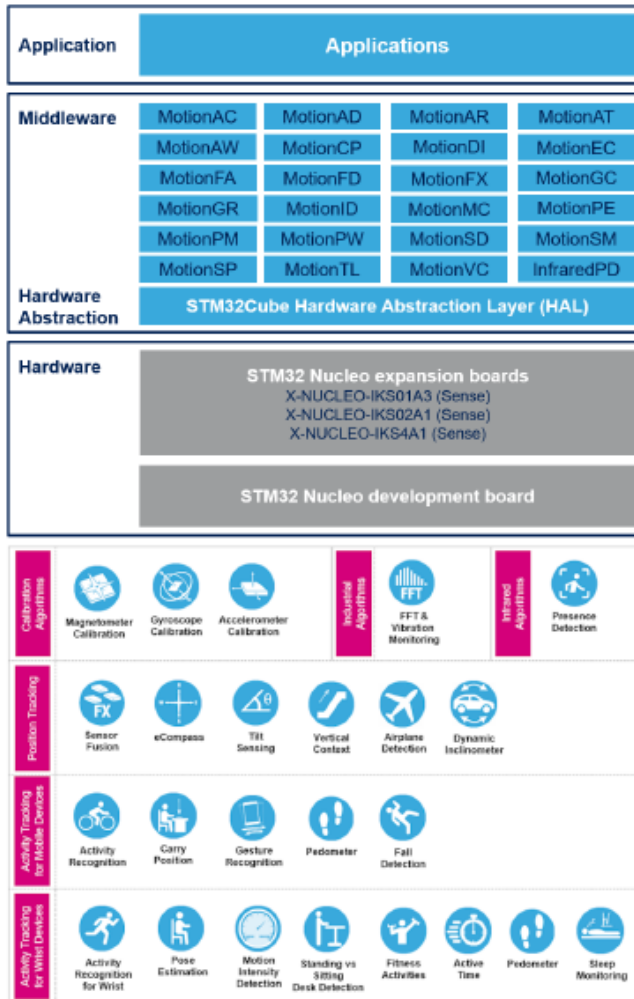
ILPS28QSW – Key features

- **Dual FS mode** for wide coverage on both altimeter & water depth.
 - Mode 1: up to 1260 hPa (1.26Bar) / **Mode 2: up to 4060 hPa (4Bar)**
- **High accuracy and resolution:**
 - ± 1 hPa @ 0~65°C (Mode 1 up to 1260 hPa)
 - $\pm 0.6\%$ of input pressure @ -40~105°C (Mode 2 up to 4060 hPa)
- **Low noise 0.32 Pa (Mode 1) / 0.57 Pa (Mode 2)**
- **GEL proven in automotive** products for harsh environment
- **10 Bar water resistant**
- **Current consumption down to 1.7 μ A**
- **Embedded temperature compensation** for precise pressure accuracy
- 2 times OPC writing available on dedicated OTP
- 8 different ODR support from 1 Hz to **200 Hz**.
- FIFO: 128 samples only pressure
- **Qvar sensor embedded**
- **Extended operating temperature: -40°C +105°C**



STMicroelectronics – X-CUBE-MEMS1

Sensor and motion algorithm software expansion for STM32Cube



Complete software to build applications using the following sensors:

- motion sensors: A3G4250D, AIS2DW12, AIS2IH, AIS328DQ, AIS3624DQ, ASM330LHH, ASM330LHHX, H3LIS331DL, IIS2DLPC, IIS2ICLX, IIS2MDC, IIS3DWB, ISM303DAC, ISM330DHCX, ISM330DLC, LIS2DH12, LIS2DTW12, LIS2DU12, LIS2DW12, LIS2MDL, LIS3MDL, LSM303AGR, LSM6DSL, LSM6DSO, LSM6DSO32, LSM6DSO32X, LSM6DSOX, LSM6DSR, LSM6DSRX, LSM6DSV16BX, LSM6DSV16X, LSM6DSO16IS
- pressure sensors: ILPS22QS, ILPS28QSW, LPS22CH, LPS22DF, LPS22HB, LPS22HH, LPS27HHTW, LPS28DFW, LPS33HW, LPS33K
- infrared sensor: STHS34PF80
- temperature and humidity sensors: HTS221, STTS22H, STTS751
- audio sensor: IMP34DT05
- X-NUCLEO-IKS4A1 expansion board with onboard LSM6DSV16X, LSM6DSO16IS, LIS2DUXS12, LIS2MDL, LPS22DF and STTS22H sensors
- X-NUCLEO-IKS01A3 expansion board with onboard LSM6DSO, LIS2DW12, LIS2MDL, LPS22HH, STTS751 and HTS221 sensors
- X-NUCLEO-IKS02A1 expansion board with onboard ISM330DHCX, IIS2DLPC, IIS2MDC and IMP34DT05 sensors

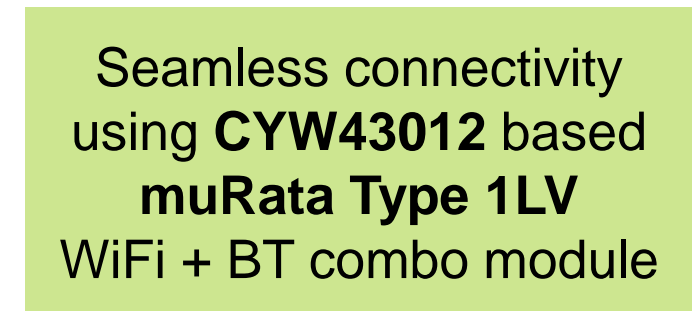
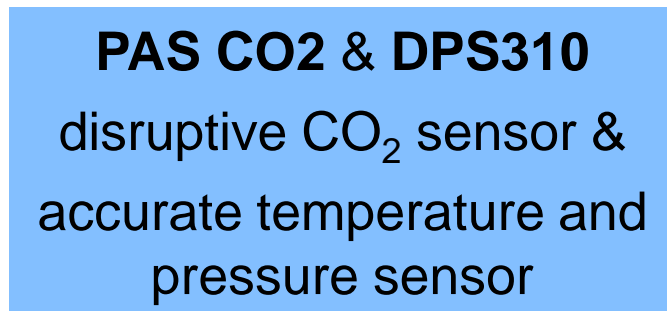
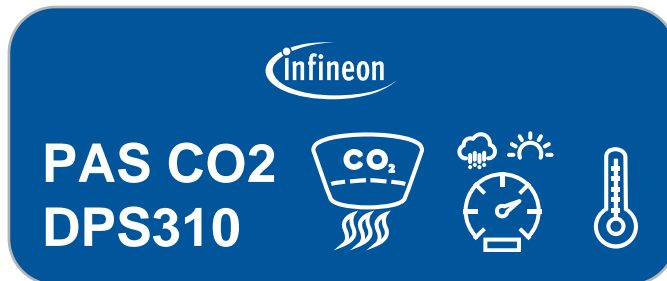
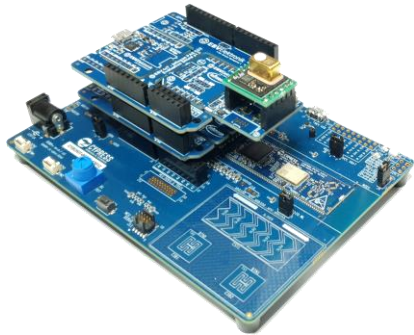


EBV-IoT – Demos and solutions



EBV-IoT – Infineon + IoTConnect Cloud connected solution

System overview





EBV-IoT – SmartCTherm WiFi Demo

System overview



The choice...

Benefit

The HS3001 sensor

a highly-accurate, fully calibrated relative humidity & temperature sensor
+ additional **ZMOD4401** – indoor air quality sensor
(+ **OB1203** HRM, SpO2, RGB)

Best candidates, providing basic environmental conditions data and advanced indoor air conditions monitoring.

RA6M3 Microcontrollers based on Cortex®-M4 core, includes TFT controller, supported by an open and flexible ecosystem concept — the **Flexible Software Package (FSP)**, built on **FreeRTOS**.

Fits best for IoT applications requiring TFT, connectivity, security, and large embedded memory.

The DA16200 module

Ultra Low Power Wi-Fi module for battery powered IoT devices with Wi-Fi AT Command Set

It adds connectivity to always-on IoT devices enabling years of battery life while maintaining continuous Wi-Fi connections

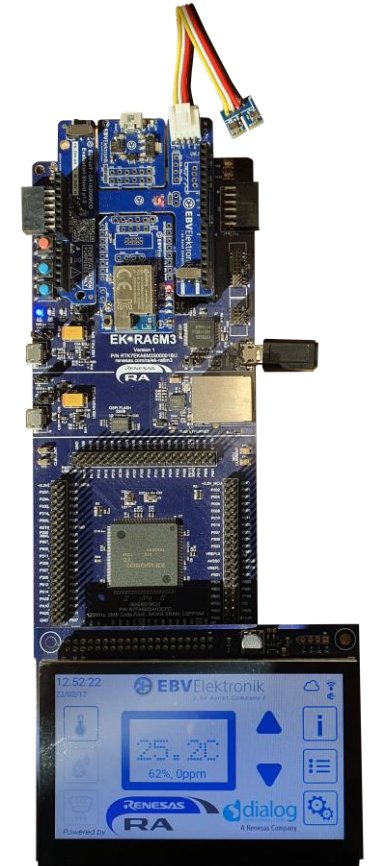


EBV-IoT – SmartCTherm WiFi Demo with voice commands

Demo includes:

- FreeRTOS running demo using Renesas EK-RA6M3G
- EBV-IoT – DA16200MOD Evaluation Shield
- Renesas HS3001 temperature/humidity sensor
- Renesas ZMOD4410 Air Quality sensor
- External Microphone
- Cloud connectivity over MQTT/WiFi connection
- Cyberon voice commands integration
- Smart Thermostat GUI example using Segger AppWizard

The shield on embedded evaluation platform with cloud connectivity

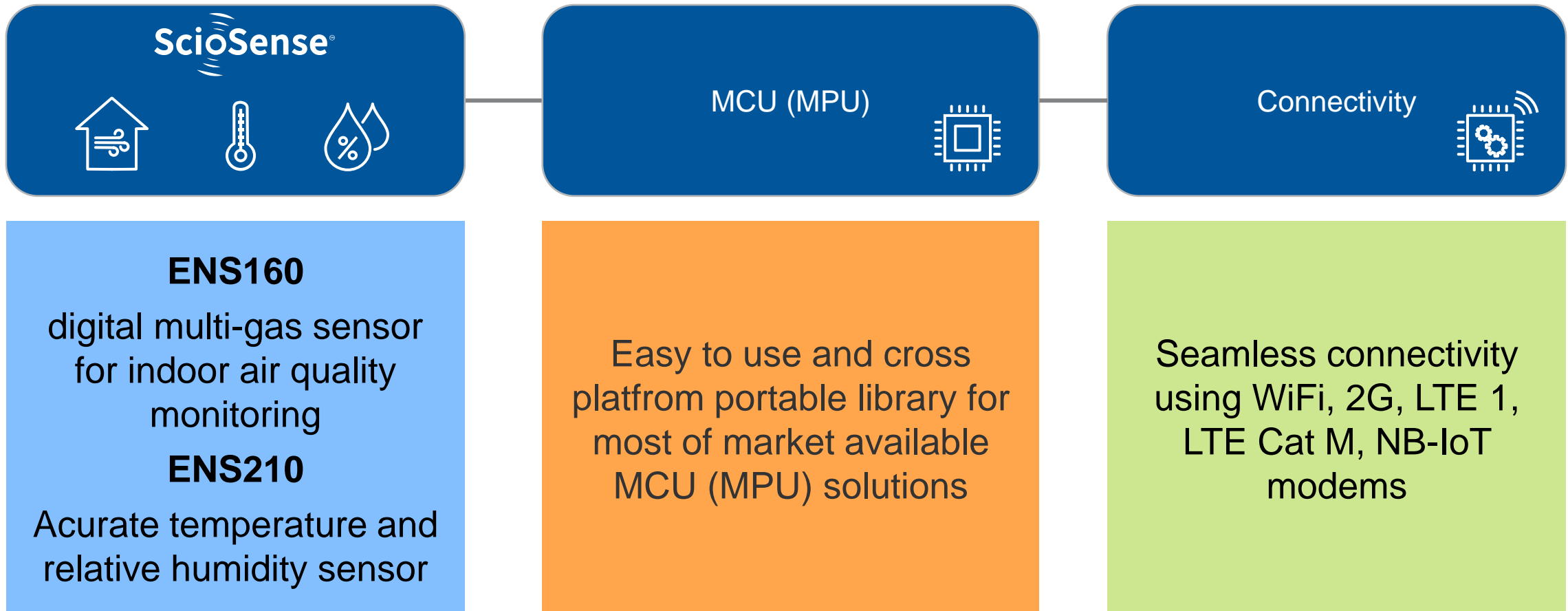


*Only available @
EBV Elektronik*



EBV-IoT – Sciosense ENS160 Air Quality Evaluation Shield

System overview



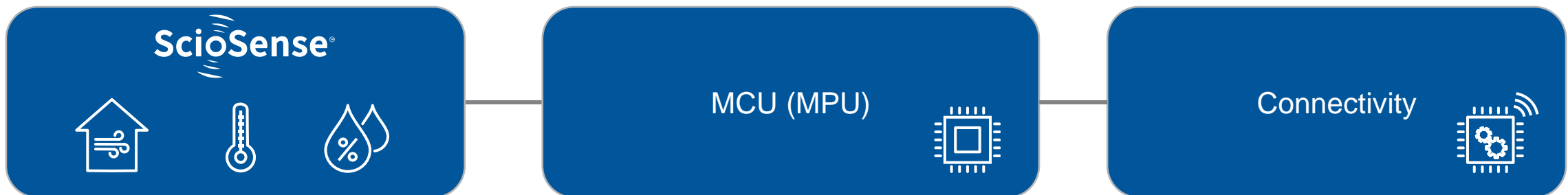
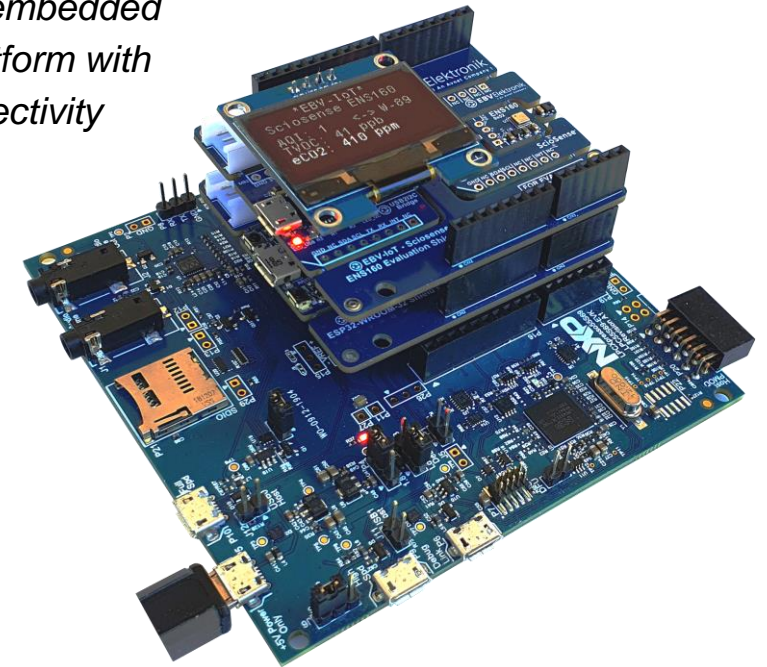
EBV-IoT – Sciosense ENS160 Air Quality evaluation shield

Embedded platform & cloud connectivity

Key Benefits:

- C source available (NXP LPC55S69 supported and extending)
- On board OLED display option
 - Displays Air Quality + Temperature & Humidity
- Cloud connectivity using WiFi modem over AT commands
- MQTT used for cloud communication

The shield on embedded evaluation platform with cloud connectivity



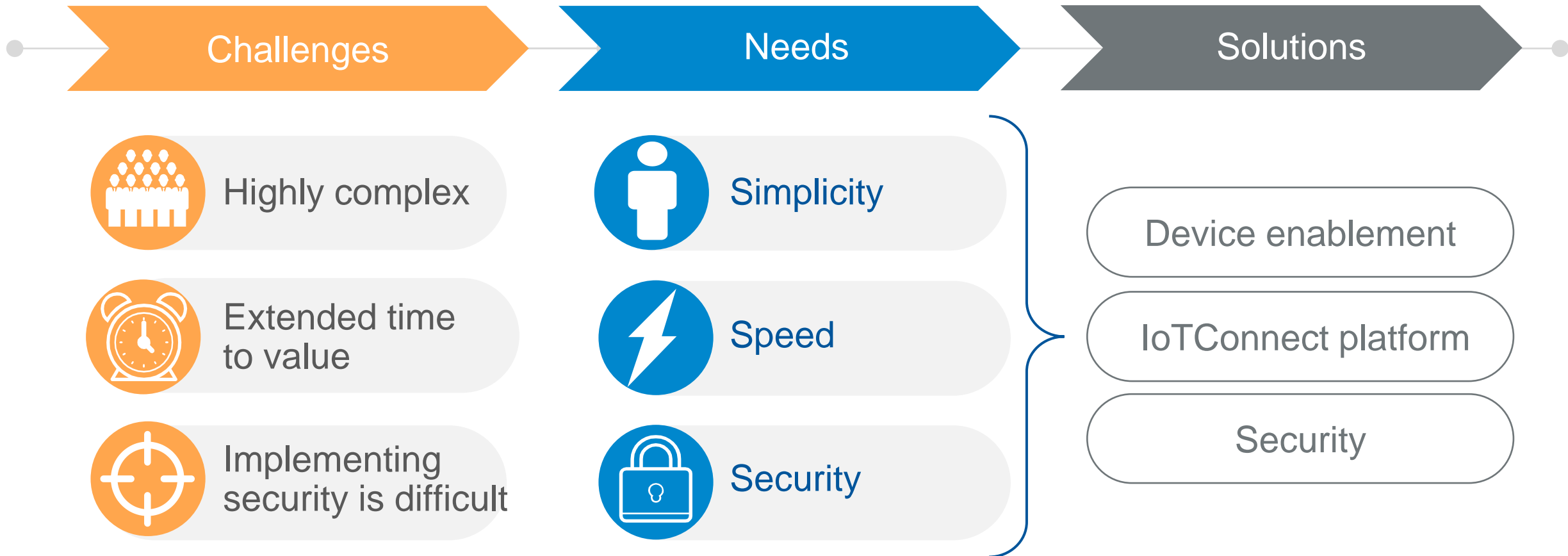
EBV Solutions



Cloud Connectivity IoTConnect



IoTConnect – „keep it simple“ cloud connectivity



/ **IOTCONNECT**®
Platform

**The IoT Solution Accelerator
for EBV customers**



An IoT platform that simplifies the complex

One platform for collaborative development and management of end-to-end IoT solutions, connecting devices to software applications, analytics and AI services to generate maximum business value.

/IOTCONNECT[®] *Secure middleware*
Platform *Powered by Microsoft Azure IoT Suite*



Smart Factory



Smart Warehouse



Smart Connected Worker



Smart Diesel Generator



Smart Asset Monitoring



Smart Fleet



Smart Retail



Smart Facility Monitoring



Smart Healthcare



Smart Building



Smart Office



Smart City Solutions



Smart Cell Tower Monitoring



Smart Energy Monitoring



Smart Greenhouse



Smart Air Quality



AI data services

- Predictive Maintenance
- Recommendation Engines
- Customer Loyalty and Retention
- Inventory Management
- Fraud Analytics
- Healthcare Analytics
- Sentiment Analysis
- Sales Forecasting

Pre-built solution accelerator SaaS applications

Valuable insights



TECHNOLOGY.

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