

# Recommended performance evaluation methodology for XENSIV™ PAS CO<sub>2</sub> sensor

**Keywords:** *gas sensor, CO<sub>2</sub> sensor, sensor evaluation*

## About this document

This application note presents a possible gas measurement setup to potential customers who would like to evaluate the performance of the XENSIV™ PAS CO<sub>2</sub>.

## Scope and purpose

There is a wide range of gas sensor products available on the market, but very few offer high-performance solutions like XENSIV™ PAS CO<sub>2</sub>. Therefore, extra care is necessary to ensure the measurement data reproduce the datasheet performance.

## Intended audience

Application engineers, test engineers, verification engineers, system engineers

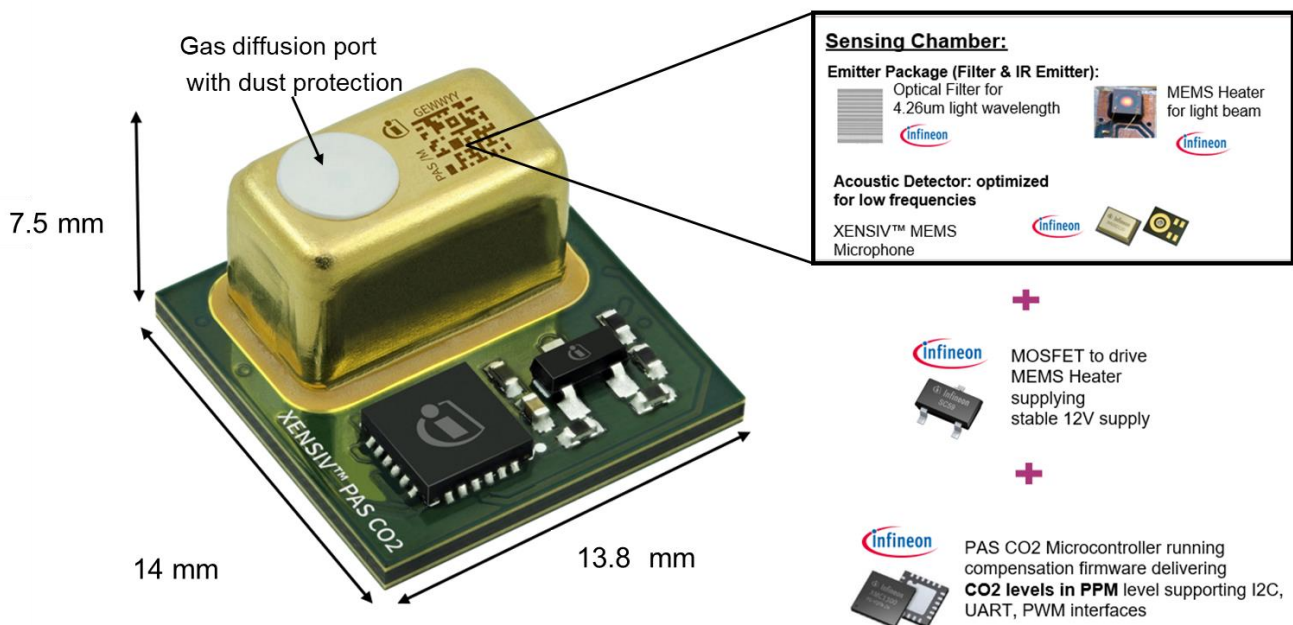
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# 1 Introduction to XENSIV™ PAS CO2

The XENSIV™ PAS CO2 is a real CO<sub>2</sub> sensor that overcomes the size, performance and assembly challenges of existing CO<sub>2</sub> sensor solutions. The sensor has been designed based on the unique photo acoustic spectroscopy (PAS) principle. XENSIV™ PAS CO2 comes in an exceptionally miniaturized module that is four times smaller and three times lighter than the existing commercial real CO<sub>2</sub> sensors that operate based on the NDIR principle. In addition to the unprecedented compact design, XENSIV™ PAS CO2 delivers superior-quality data thanks to its high-accuracy performance beating state-of-the-art CO<sub>2</sub> gas sensors. The sensor’s high accuracy level makes it the right choice for indoor air-quality monitoring stations, HVAC systems and IoT applications.

All major components of XENSIV™ PAS CO2 are developed and designed in-house according to Infineon’s high-quality standards (e.g., component traceability, internal and external audits, state-of-the-art qualification standards and tools). As shown in Figure 1(a), outside of the cavity there is an XMC™ microcontroller to support data processing and a MOSFET to drive the light source. Within the cavity, there is a high-SNR silicon microphone as the detector and an in-house built MEMS-based infrared emitter as the light source.



**Figure 1 All the key components of XENSIV™ PAS CO2 are developed in-house to ensure best-in-class quality of the sensor**

*Note: Before performing the evaluation, it is recommended to perform Forced Compensation Scheme (FCS) or enable Automatic Baseline Offset Correction (ABOC) for long-term test.*

Recommended gas measurement setup

## 2 Recommended gas measurement setup

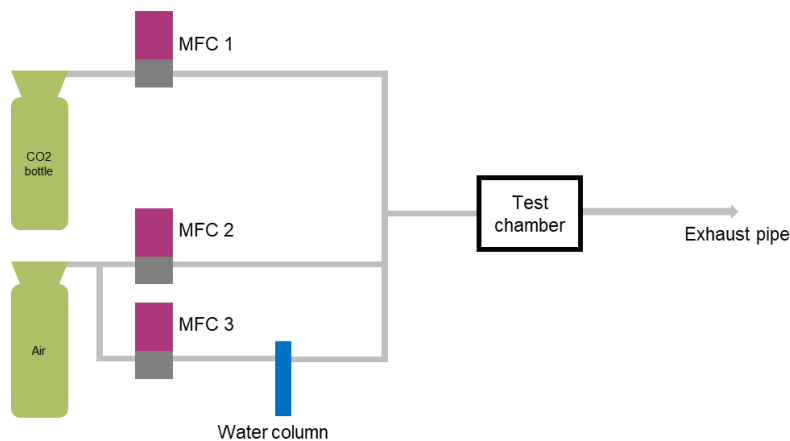
A gas measurement setup should have three main components:

- Gas mixing system
- Test chamber
- Reference sensors

In the following section, a brief description of each component is provided.

### 2.1 Gas mixing system

To deliver the target CO<sub>2</sub> concentration to the gas chamber, a gas mixing system should be used. The schematic of a typical setup is presented in Figure 1. To control the gas and humidity concentration at least three mass flow controllers (MFCs) are needed. For the example setup, MFC 1 is being used for the CO<sub>2</sub> bottle. A synthetic air gas bottle is connected to MFCs 2 and 3, which are used to dilute the gas concentration within the gas bottle to achieve an ideal target gas concentration. MFC 2 is maintaining the dry airflow, whereas MFC 3 is maintaining the wet airflow via a water column. By varying the flow ratio between dry air and wet air, the relative humidity can be controlled. Alternatively, a humidity generator can also be used to maintain a stable relative humidity point.



**Figure 2 Gas mixing system to transfer exact CO<sub>2</sub> concentration to the gas chamber**

To achieve a target gas concentration at specific relative humidity, the following equation (i) needs to be used:

$$T_c = \frac{B_c \times G_f}{D_f + W_f + G_f} \tag{i}$$

Where,

T<sub>c</sub> = Target gas concentration (ppm)

B<sub>c</sub> = Bottle concentration (ppm)

G<sub>f</sub> = CO<sub>2</sub> gas flow (SCCM)

D<sub>f</sub> = Dry air flow (SCCM)

W<sub>f</sub> = Wet air flow (SCCM)

## PAS CO2 sensor

### Recommended gas measurement setup

Target relative humidity can be achieved by varying the ratio between  $D_f$  and  $W_f$ .

For example, if a sensor needs to be characterized at a room temperature and atmospheric pressure with a 50000 ppm (5 percent) gas bottle concentration at 500 SCCM flow, then a typical gas measurement protocol can be as follows:

**Table 1 Experimental conditions**

Target CO <sub>2</sub> concentration [ppm]	Time [min]	MFC 1 [SCCM]	MFC 2 [SCCM]	MFC 3 [SCCM]
Air 50 percent RH	30	0	250	250
Air 50 percent RH + 400 ppm CO <sub>2</sub>	15	4	246	250
Air 50 percent RH	30	0	250	250
Air 50 percent RH + 1000 ppm CO <sub>2</sub>	15	10	240	250
Air 50 percent RH	30	0	250	250
Air 50 percent RH + 5000 ppm CO <sub>2</sub>	15	50	200	250
Air 50 percent RH	30	0	250	250

## 2.2 A typical test chamber

A test chamber needs to be designed in such a way that there is no leakage, and it can maintain laminar flow while exposing the sensor to the target gas concentration. Inside the test chamber, it is recommended to accommodate a reference CO<sub>2</sub> sensor. Additionally, to get an overview of the complete test conditions, pressure sensor, humidity sensor and temperature sensor should also be considered.

## 2.3 Recommended reference sensors

### 2.3.1 CO<sub>2</sub> reference sensor

Vaisala GMP343 is recommended as the reference CO<sub>2</sub> sensor. Further details of this product can be found on the product [page](#).

### 2.3.2 Pressure and temperature reference sensor

Infineon's XENSIV™ DPS368 is recommended as the reference pressure and temperature sensor. The pressure sensor's pressure output comes with excellent precision of  $\pm 0.002$  hPa and relative accuracy of  $\pm 0.06$  hPa. The built-in temperature sensor offers an accuracy of  $\pm 0.5^\circ\text{C}$  with  $0.01^\circ\text{C}$  data resolution. Further details of the product can be found [here](#).

### 2.3.3 Reference relative humidity sensor

A highly accurate low-powered relative humidity sensor should be considered as the reference relative humidity sensor.

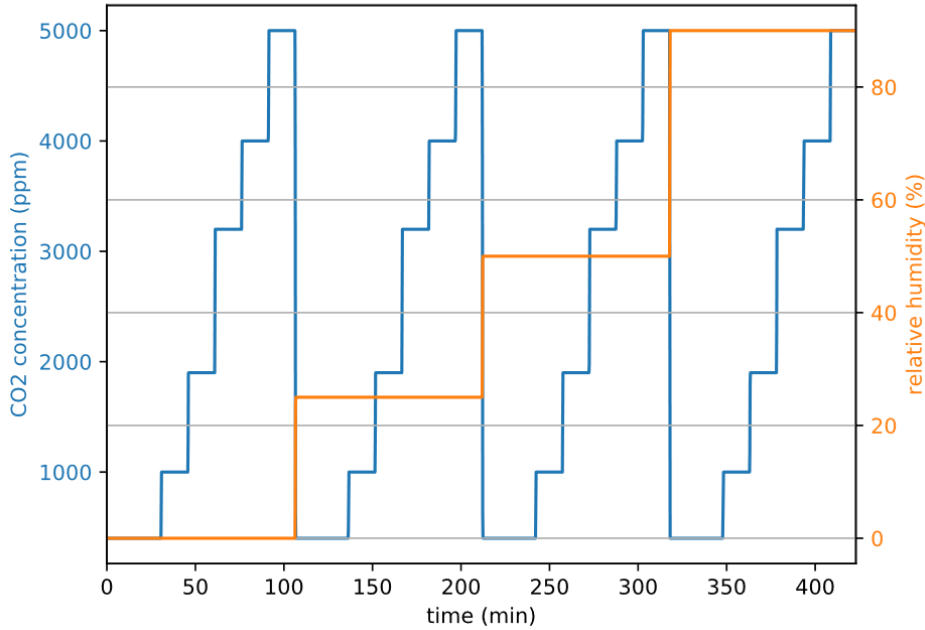
### 3 Typical performance evaluation of XENSIV™ PAS CO2

Example test condition:

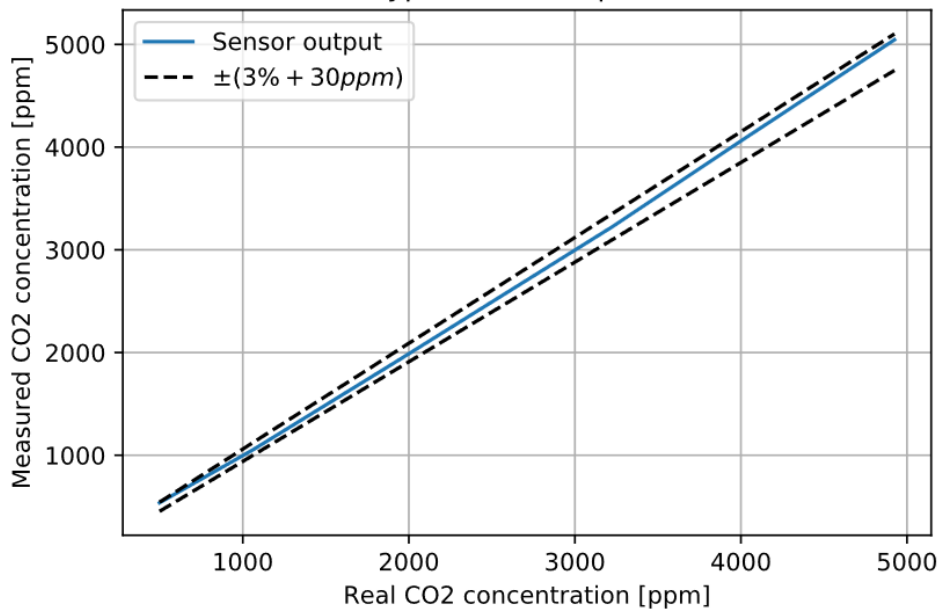
- Relative humidity 0%, 23%, 50% and 85%
- Ambient pressure 960 hPa
- CO2 concentration steps: 1000 ppm, 1800 ppm, 3100 ppm, 4000 ppm and 5000 ppm

**Gas ramp for sensor accuracy evaluation**

T = 25°C, p = 960 hPa, flow = 500 sccm



**Typical CO2 response**



**Revision history**

**Revision history**

<b>Document version</b>	<b>Date of release</b>	<b>Description of changes</b>
V1.0	02.06.2021	Creation
V1.2	01.07.2022	Minor correction

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