Recommended performance evaluation methodology for XENSIV™ PAS CO2 sensor

Keywords: gas sensor, CO_2 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 CO2.

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 CO2. Therefore, extra care is necessary to ensure the measurement data reproduce the datasheet performance.

Intended audience

Application engineers, test engineers, verification engineers, system engineers

Table of contents

1 Introduction to XENSIV™ PAS CO2

The XENSIV™ PAS CO2 is a real CO_2 sensor that overcomes the size, performance and assembly challenges of existing CO_2 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_2 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_2 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.

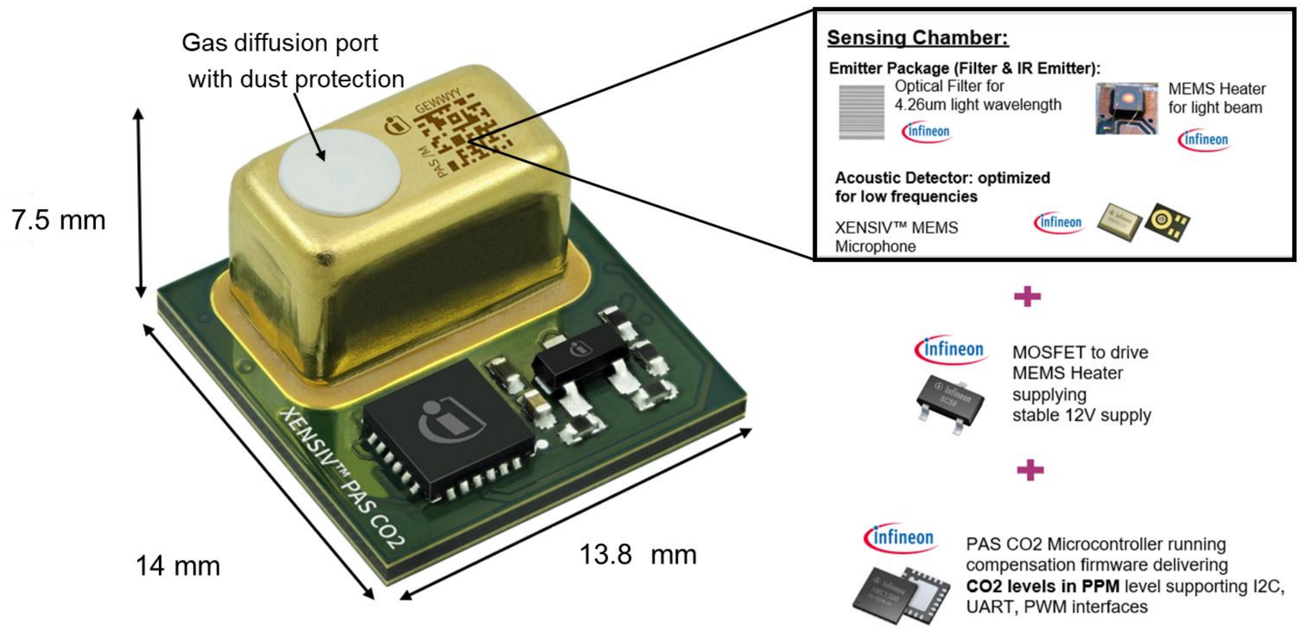


Figure 1 All the key components of XENSIV™ PAS CO2 are developed in-house to ensure best-in-class quality of the sensor

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.

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_2 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_2 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.

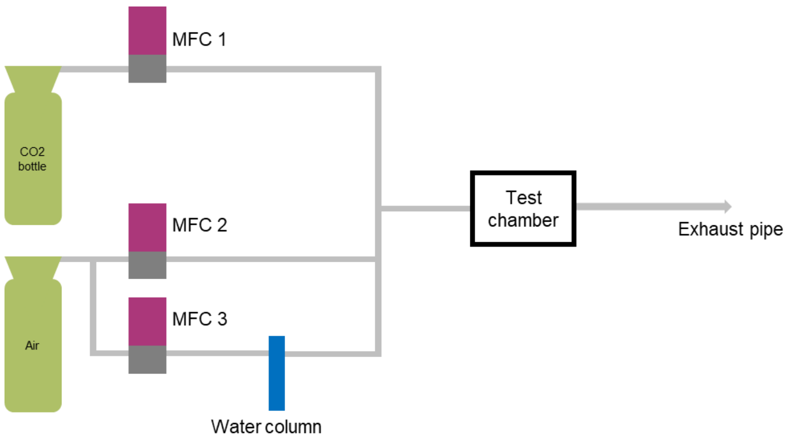


Figure 2 Gas mixing system to transfer exact CO_2 concentration to the gas chamber

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

$$T_c = \frac{B_c \times G_f}{D_f + W_f + G_f} \qquad \text{(i)}$$

Where,

T_c = Target gas concentration (ppm)

B_c = Bottle concentration (ppm)

G_f = CO_2 gas flow (SCCM)

D_f = Dry air flow (SCCM)

W_f = Wet air flow (SCCM)

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_2 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_2	15	4	246	250
Air 50 percent RH	30	0	250	250
Air 50 percent RH + 1000 ppm CO_2	15	10	240	250
Air 50 percent RH	30	0	250	250
Air 50 percent RH + 5000 ppm CO_2	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_2 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_2 reference sensor

Vaisala GMP343 is recommended as the reference CO_2 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 ± 0.002 hPa and relative accuracy of ± 0.06 hPa. The built-in temperature sensor offers an accuracy of ±0.5°C with 0.01°C data resolution. Further details of the product can be found here.

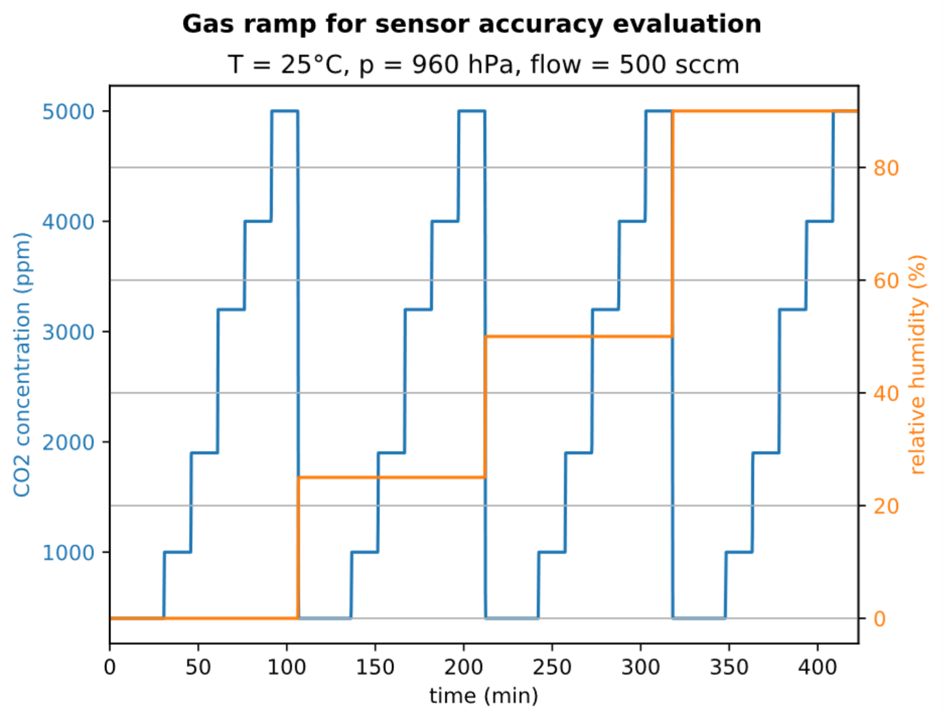
2.3.3 Reference relative humidity sensor

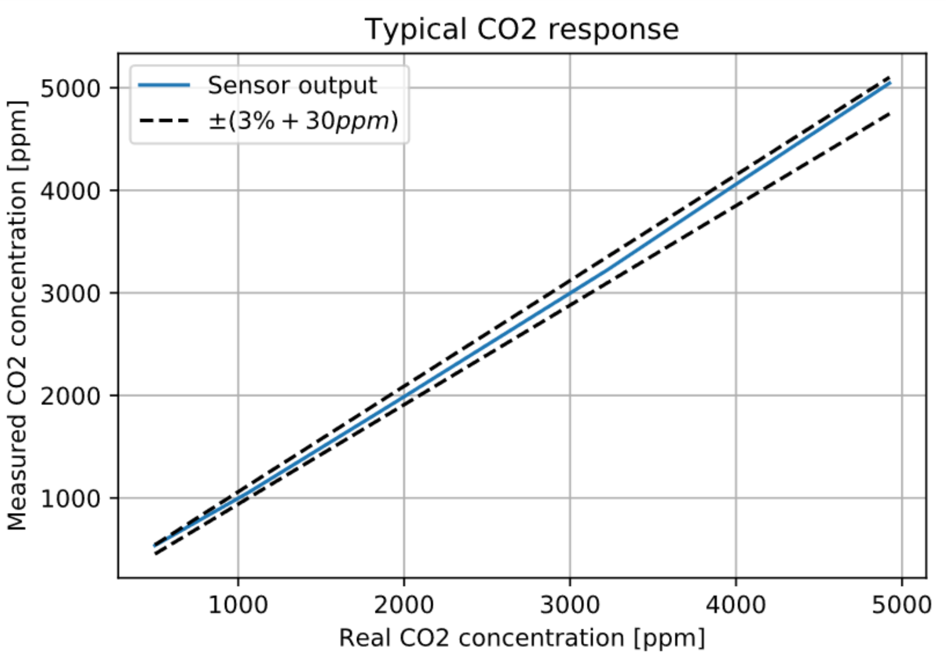
A highly accurate low-powered relative humidity sensor should be considered as the reference relative humidity sensor.

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





Revision history

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

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