Design-In Guide

For Integrating SGP4x Gas Sensors

Sensirion's SGP4x gas sensor are highly accurate and long-term stable metal-oxide indoor air quality sensors. To take full advantage of their outstanding performance, a few design-in rules must be followed. This guide describes an easy-to-implement and affordable design-in to achieve a superior performance. In addition to this document, it is recommended to consult the *Handling and Assembly Instructions for SGPxx Gas Sensors* to guarantee the Sensirion's SGP4x gas sensor's specified accuracy.

Introduction

Environmental sensors, unlike standard electrical components, need to be exposed to the environment they are supposed to sense.
Sensirion's SGP4x gas sensors are designed and optimized to measure indoor air quality. The Sensirion SGP4x gas sensors come with a lot of functionalities to ensure high performance and minimize work on your side. To experience and make use of all these functionalities, it is advised to follow the steps described below precisely and accurately. It is recommended at this point to read the documentation available for the SGP4x to fully understand the concepts of indoor air quality and the working principles of Sensirion's SGP4x gas sensor.

Figure 1 Outline of the document

This document guides the reader through the whole process of integrating the SGP4x gas sensor best. It starts with the definition of an acceptable sensor position and describes the optimal integration into the device. In a third step, a quick sanity check is presented to get an idea on how well the chosen design performs and finally a few points about the finalization of the design in are presented.

1. Placement of Sensor

In order to benefit most from the outstanding sensor performance, it is important to integrate the sensor at a position that allows maximum exposure to the ambient. This is important because the sensor is supposed to measure the surrounding air at minimum disturbance due to the device.

Coupling to ambient

Ideally, the sensor is placed as close as possible to the device's outer shell with a large opening allowing the sensor to be exposed to the ambient. The larger the opening, the better the air exchange between the sensor's direct surrounding and the ambient. Design restrictions often limit the opening and finding a placement where an opening does not harm the design is not always possible, see **Figure 2** for some opening options.

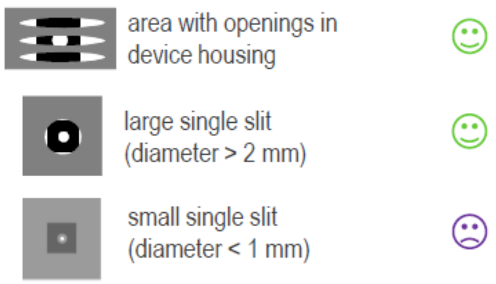


Figure 2 Influence of openings.

Devices stand on the table or are wall mounted. Such surfaces can be a source of VOCs which are emitted, *e.g.*, from paints, cleaning agents, or polishes. It is therefore important that the sensor is faced towards the ambient environment and not directly to such a surface to avoid potential false readings. If, for design or practical reasons, a facing towards a surface cannot be avoided, it is advised that the distance between surface and the device's sensor opening is at least in the range of 1 cm (~0.5 in.).

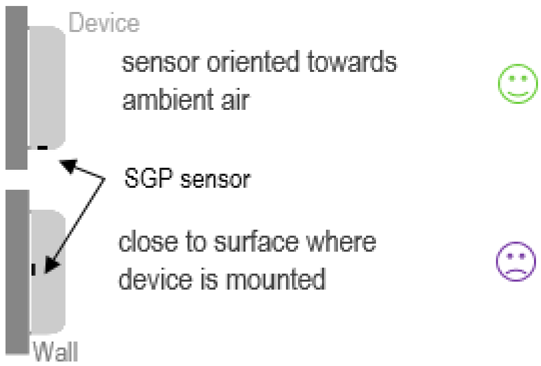


Figure 3 Sensor orientation in a device.

Decoupling from internal heat sources

All Sensirion SGP4x gas sensors are temperature controlled and do not show a temperature dependency. In a device however, the sensor is surrounded by material that often outgases which leads to a background signal. This outgassing of the material increases with temperature. A higher background signal affects the sensor's reading by leading to a constant signal and masking small environmental events. Therefore, the system of the integrated Sensirion SGP4x gas sensor with the surrounding, outgassing material is temperature dependent.

To avoid such a temperature dependence, it is important to place the sensor in the device's coldest part. Typically, the largest heat sources in an electronic device are the CPU, the display, the Wifi module, and batteries.

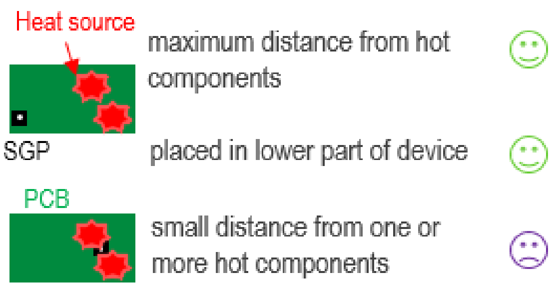


Figure 4 Placing the sensor in the coldest part of the device.

To profit from convection produced by internal heat sources, it is further recommended to place the sensor in the lower part of the device.

2. Integration of the Sensor

Having an appropriate opening and position for the sensors is only the first step. In a second step, the sensor design-in must be optimized to take full advantage of the opening. The main goal of the mechanical design-in is to ensure a fast and accurate sensor response to environmental changes at minimum cross talk due to device-internal outgassing. Key features of an optimal mechanical design-in are a small distance between opening and sensor as well as good sealing towards the device interior. Design-in suggestions will be discussed in the following paragraphs.

Distance to opening

For good coupling to the environment and a fast response time it is important to keep the distance between opening and sensor as small as possible. Facing the sensor's top surface against the opening further minimizes the distance between sensing element and environment.

Sealing against device interior

One of the most important features of a mechanical design-in is the sealing. Electronic components, batteries, PCBs, and plastic parts of typical devices emit VOCs. They accumulate inside the device to high concentrations. Without any sealing the VOCs emitted by the device can reach the sensor and mask environmental VOC changes. It is therefore recommended to use a silicone or rubber sealing compressed between the housing and the PCB or Flex-PCB. If for any reason no sealing material can be integrated, it might be sufficient to minimize the gap between housing and PCB. However, it is required to plan for a wide and short opening to optimize the coupling to the environment.

Surrounding material

The right choice of materials in the vicinity of the sensor is very important. A material that outgases next to the SGP4x gas sensor will lead to an unwanted background signal.

Recommended	*Not recommended*
• Hard plastics (*e.g.*, ABS, PC) • PTFE/Teflon • Peek • Metals	• PA • POM • PMMA

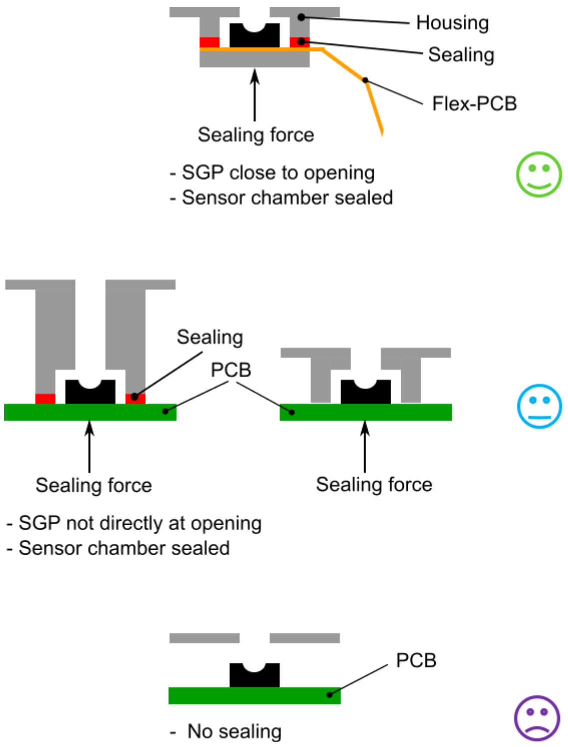


Figure 5 Mechanical design-in recommendations. Key features are a small distance between opening and sensor as well as a good sealing towards the device interior.

3. Design-In Sanity Check

After having built a first prototype, a quick sanity check will give a hint on the design's performance. Besides the prototype, one needs a reference and a VOC source. We propose to use a Sensirion evaluation kit equipped with an SGP4x gas sensor as reference and an ink pen as VOC source. Place your device and the reference 10 cm / 4 in. apart and expose the source in the middle.

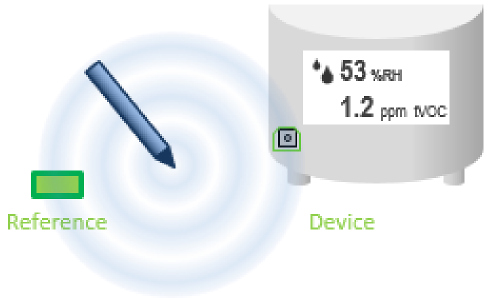


Figure 6 Quick functionality test of the design-in.

Use the reference to check if there is a signal. In case there is not, change the VOC source. In case there is a signal, check the response of your device. Once a clear increase in signal is visible, remove the source and the check the device's recovery. The table below states what number to expect from a good design-in.

Reaction times	Design-in
Fast rise (<30 s) and recovery (<1min)	🙂
Slow rise (>30 s) and recovery (>1 min)	😐
Little effect on gas measurement in device	🙁

4. Finalization of Design-In

Once an adequate design is found, a few additional steps are needed to finalize the SGP4x gas sensor integration.

ESD protection

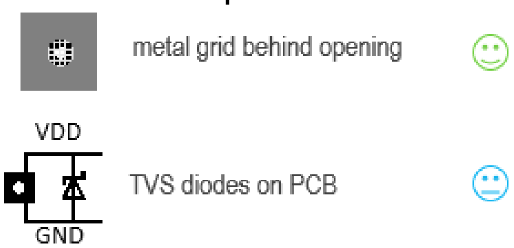
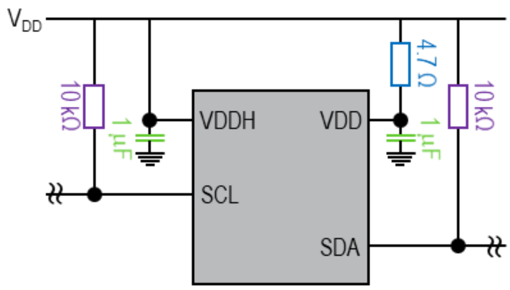


Figure 7 ESD protection.

A large meshed metal grid in front of the sensor's opening helps to protect the SGP4x gas sensor against ESD. A TVS diode on the PCB is another possibility.

Capacitor and pull-up resistors

The VDD pin must be decoupled with an RC element (recommended: 4.7 Ω and 1 μF) which must be placed as close a possible to the SGP4x between these two lines. The required decoupling for VDDH depends on the power supply network connected to the sensor, a capacitor of 1 μF is recommended. VDD and VDDH must be connected to one single supply VDD.



- ✓ capacitor close to SGP4x to decouple power supply pins from GND
- ✓ resistor close to SGP4x to decouple VDD from VDDH
- ✓ pull-up resistors to VDD for both I²C lines (SDA, SCL)

Figure 8 Electronic integration of the SGP4x sensor.

Furthermore, two pull-up resistors must be introduced to pull the signals SDA and SCL high. We propose a 10 kΩ resistor each. However, the bus capacity requirements must be taken into account as well.

No dust protection needed

Each SGP4x gas sensor comes with an attached dust protection membrane, thus no additional membrane is needed.

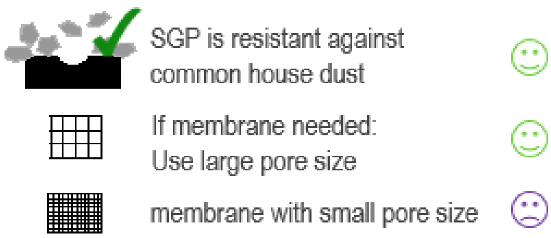


Figure 9 Additional protection membranes.

If for other reasons an additional protection membrane is added to the device, please consider using a membrane with a large pore size to ensure a fast gas exchange through the membrane.

5. Combining SGP4x and SHTxx

In many cases, the SGP4x gas sensor is used along with an SHTxx humidity and temperature sensor. Whereas the SHTxx does not influence the SGP4x gas sensor in any way, the dissipated heat of the SGP4x can lead to positive temperature offset for the SHTxx sensor. This section will describe how to integrate an SHTxx and a SGP4x in the same device.

For the SHTxx most design-in rules of the SGP4x sensor also apply. For a more in depth reading, it is recommended to read *SHTxx and STSxx Design Guide.*

To minimize the heat transfer through solid material (conduction), *i.e.*, through the PCB, we advise to use two flex PCBs, one for each sensor, to connect to the main PCB. This will minimize the heat transfer through conduction. If for design or cost reasons, this solution is not possible, the two sensors should be placed as far apart from each other as possible. Experience showed that a distance of around 2 cm (~0.8 in.) and milling slits in the PCB around the SHTxx is sufficient.

In addition, heat transfer through convection should also be considered. Integrating the two sensors in separate dedicated volumes is beneficial and recommended. If, for some reason, this is not practical, it needs to be considered that warm air raises. Thus the SHTxx sensors needs to be integrated in a lower spot than the SGP4x gas sensor.

The two sensors come with different I^2C addresses. Therefore, they can be connected to the same serial bus.

Revision History

Date	Version	Page(s)	Changes
June 2020	1.0	–	–

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