SENSIRION

Design-in Guide SFA30

For the SFA30 Formaldehyde Sensor Module

In order to take full advantage of the SFA30 sensor module's performance and its integrated features a number of design-in recommendations need to be considered. This application note describes an easy-to-implement and affordable design-in of Sensirion's formaldehyde sensor module. Please note that unbeneficial housing and/or system designs may cause significant formaldehyde (HCHO) deviations, increased noise levels as well as highly increased response times.

Content

1 Overview: The Most Important Design-in Recommendations

The SFA30 formaldehyde sensor module has to interact with the environment in order to sense the formaldehyde (HCHO) concentrations, relative humidity and temperature.

a) Sensor has good coupling to the environment and is sealed from device internals to reduce the dead volume

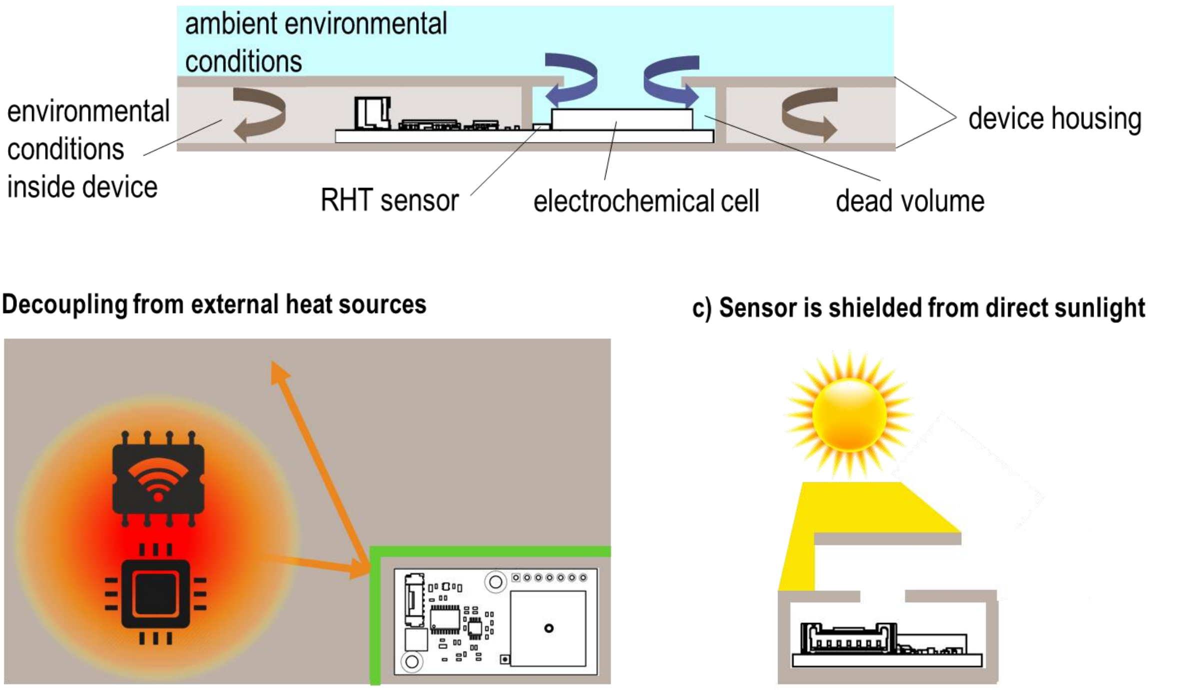

Figure 1: Most important design-in recommendation for the SFA30 formaldehyde sensor module. **(a)** Good coupling to the environment thanks to a large opening of the device housing in proximity to the sensor's sensing area and thanks to a small dead volume surrounding the sensing area. **(b)** Good decoupling from external heat sources such as MCU or Wifi module. Since hot air has the tendency to rise it is recommended to place the sensor in the lowest part of the device. **(c)** Shielding from direct sunlight thanks to the addition of a light-shade in the device housing.

General note: The latest version of the "*SHTxx and STSxx Design Guide*" applies. For optimal RHT performance it should be followed in conjunction with the design-in recommendations in the following sections.

2 The Most Important Design-in Recommendations in Detail

2.1 Coupling to the environment

The SFA30 has to interact with the environment in order to sense the ambient HCHO concentration, relative humidity and temperature. Therefore, coupling the SFA30 to the environment via a suitable device design is of utmost importance. Bad coupling to the ambient environment can result in significantly decreased performance and increased response time. General design-in recommendations are illustrated in Figure 2.

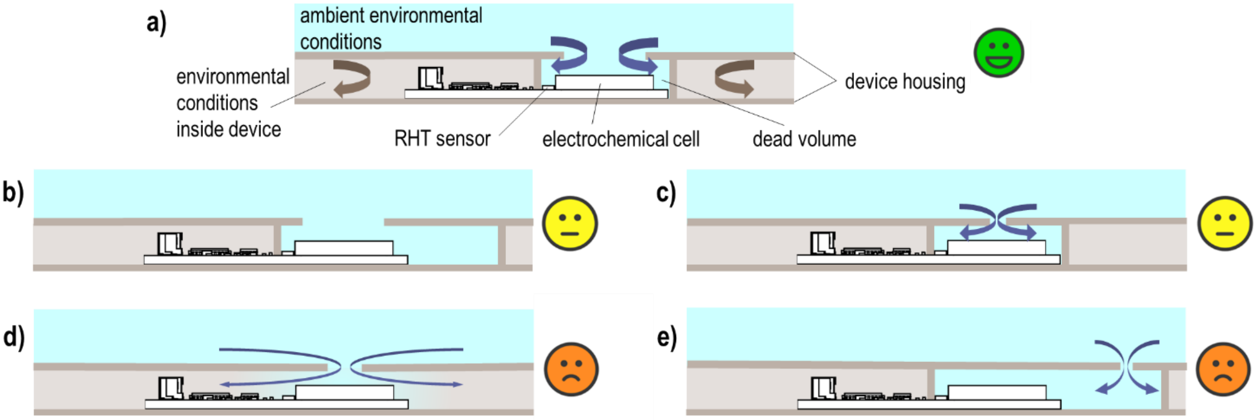

Figure 2: Sensor coupling to ambient environment. **(a)** Good coupling to ambient thanks to large aperture in proximity to sensor's electrochemical cell as well as the RHT sensor and thanks to a small dead volume around the electrochemical cell and the RHT sensor. **(b)** Moderate coupling to ambient due to large dead volume and **(c)** small aperture in the device housing. **(d)** Poor coupling because of missing sealing from air entrapped in housing and **(e)** due to small opening that is far away from the sensor's electrochemical cell as well as the RHT sensor.

Sensor has good access to environment
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 ambient. The larger and closer the opening, the better the air exchange between the sensor's direct surrounding and the outside environment.

Dead volume enclosed around sensor is small
The larger the dead volume the more air needs to be exchanged until the environmental and sensor conditions match. It is thus recommended to keep the dead volume as small as possible. Ideally, the sensor is also sealed from air entrapped in the device's housing to further minimize the dead volume (i.e. volume of air that surrounds sensor inside device housing). Large dead volumes can increase the response time of the sensor significantly.

2.2 Decoupling from external heat sources

External heat sources in direct proximity to the SFA30 sensor module can have a significant effect on the measured temperature. Therefore, the SFA30 should be decoupled from heat sources as depicted in Figure 3. This is especially important if the RH and T output signals are relevant for the customer application. Typically, the largest heat sources in an electronic device are the CPU, the display, the Wifi module and batteries.
While heat sources with constant heating can be compensated compensation of non-constant heat sources is complex. To minimize the effect of external heat sources, the sensor should be placed in the device's coldest part. Typically, lowest self-heating can be realized by placing the SFA30 sensor module in the lowest part of a device and having maximal distance to self-heating components.
If a sufficient distance between sensor and heat sources cannot be implemented, contact of heated air with the sensor can also be avoided by shielding the sensor physically from all heat sources. Additionally, there should be sufficient heat transfer out of the device to avoid the heating of the complete housing.

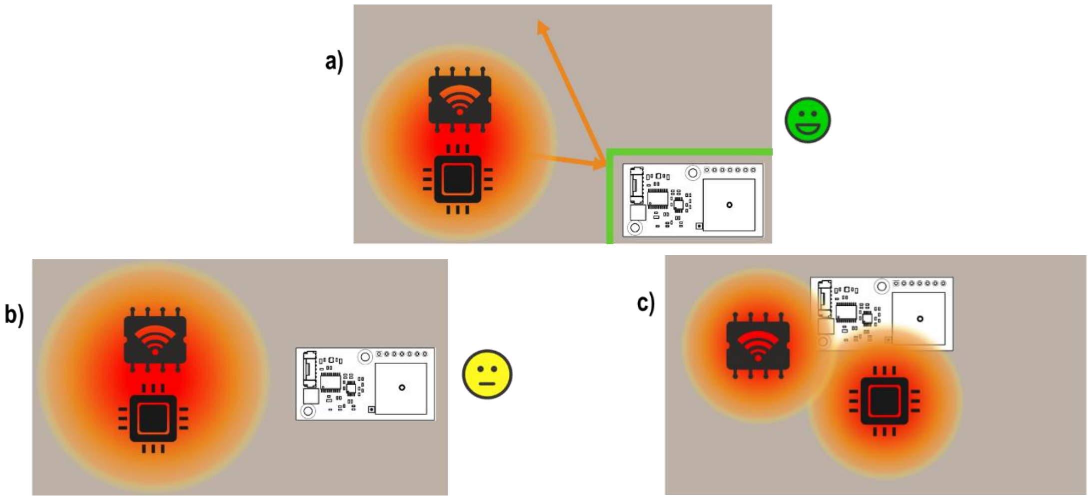

Figure 3: Sensor coupling to external heat sources (top view).The red circles indicate heat that emanates from self-heating components. **(a)** Good decoupling from external heat sources. A wall (green) shields the sensor from the heated air. An additional opening on top of the device housing can avoid the heating of the complete housing. **(b)** The heated air gets in direct contact with the sensor which will cause increased temperature readings. **(c)** Bad decoupling from external heat sources due to immediate proximity to self-heating components.

2.3 Protection from sunlight

Exposing the SFA30 sensor module to direct sunlight might introduce temperature offsets that affect the HCHO, RH and T output. Additionally, direct sunlight can accelerate the ageing of the sensor and consequentially reduce its service life. It is thus recommended to protect the sensor from direct sunlight. This can be achieved by a suitable design-in or by using a light shade (see Figure 4).

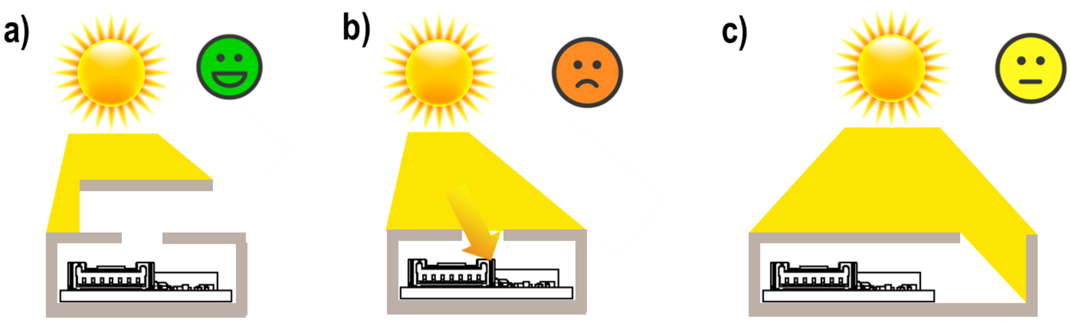

Figure 4: Sensor protection from sunlight (connector view). **(a)** Good protection and **(b)** bad protection from incoming sunlight. **(c)** Good protection from sunlight, however, at the cost of bad coupling to ambient and a large dead volume.

3 Mechanical Integration

The mechanical integration of the SFA30 sensor module can be done in various ways. Depending on the application and the performance requirements, the following design-in guidelines have to be implemented more or less strictly.

Some key aspects of the mechanical integration are discussed below.

3.1 Mechanical mounting and orientation

Mechanical mounting

The PCB of the SFA30 sensor module features two mounting holes[1] which can be used for different purposes – separately or at the same time:

- to easily fixate the sensor inside the device's housing e.g. by screws or other means;
- as positioning and alignment aids of the SFA30's PCB inside the device housing during assembly; or
- as supporting points to establish a defined distance between SFA30 sensor module and housing structure[2].

It is up to the customer to decide how to utilize the mounting holes. At best, all of the three listed purposes are taken into account during design-in of the SFA30 sensor module.

PCB orientation

Even though the power consumption of the SFA30 sensor module is very low, it is recommended to integrate the SFA30 sensor module orientated with the onboard Molex connector facing upwards or to the side to prevent the raising heat from the CPU to heat up the electrochemical cell. This recommendation should be taken into account in addition to those provided in section 2.2 in order to maximize the sensor's performance.

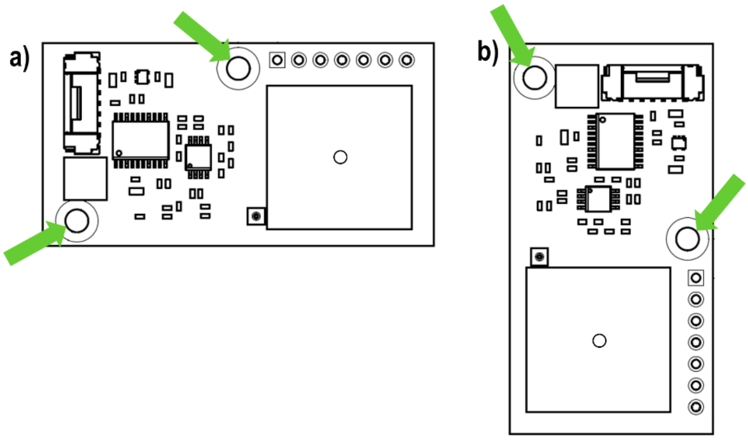

Figure 5: Mechanical mounting (two mounting holes indicated by green arrows) and recommended orientation of SFA30 sensor module with the Molex connector facing **(a)** sidewards and **(b)** upwards.

3.2 Coupling to ambient conditions

The sensing elements of the SFA30 sensor module, namely the electrochemical cell and the onboard Sensirion RHT sensor, should be placed as close as possible to an aperture in the device housing (see also section 2.1). Apertures can be realized for example in the form of slot or a hole patterns. The larger the aperture's surface in the device housing compared to the air volume trapped between SFA30 sensor module and housing walls, the faster is the response time of the SFA30 sensor module to changing ambient conditions outside of the device housing.

[1] See the SFA30 datasheet for detailed dimensions and positioning of the mounting holes.
[2] Use the height of the Molex connector as in indication of the minimum allowed distance.

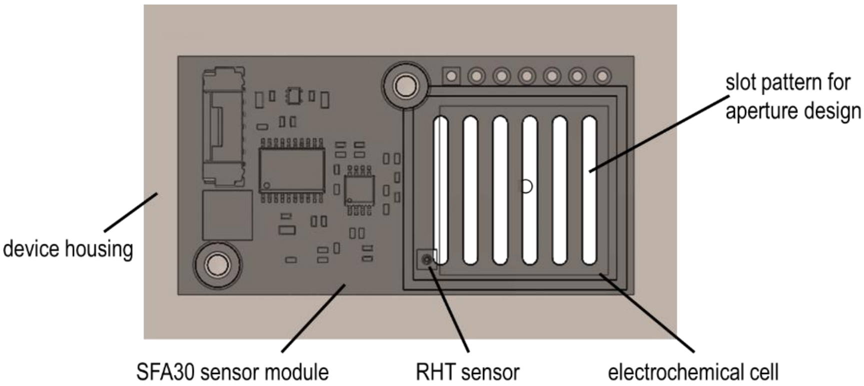

Figure 6: Exemplary aperture design with a slot pattern above the sensing elements of the SFA30 sensor module.

3.3 Reducing the impact of environmental conditions inside the device on sensing performance

As the SFA30 sensor module is supposed to measure changes of the environmental conditions outside the device, its output signal should be affected as less as possible by the device's internal environmental conditions (see also section **Error! Reference source not found.**). Depending on the local conditions of the sensor integration, different mechanical s ealing and shielding efforts are thus advisable.

The area marked in light green in Figure 7 can be used to fully enclose the sensing elements of the SFA30 sensor module. A possible realization of such an enclosure can be a simple injection molded partitioning wall being an integral part of the device's housing design. Taking the tolerances of the PCB and the injection molded structures into account the partitioning wall probably ends shortly above the PCB, leaving a small air gap. However, this should provide a sufficient sensor performance for the majority of applications.

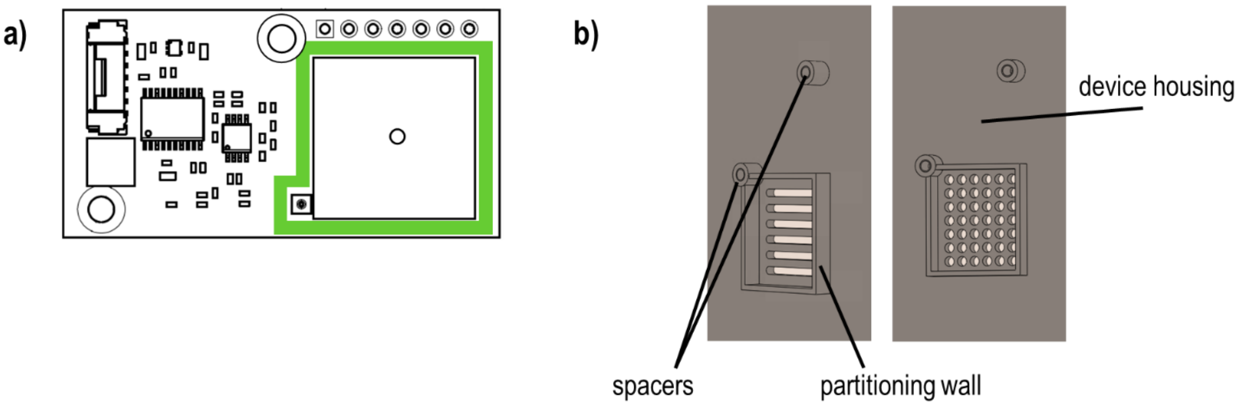

Figure 7: Sealing and shielding around the sensing elements of the SFA30 sensor module to prevent or at least reduce the impact from local environmental conditions inside the device on the sensing performance**(a)** Top view: area marked in light green to be used for sealing or shielding purposes and **(b)** Internal view of device housing: exemplary implementation of partitioning walls surrounding the sensing elements including two possible aperture designs.

Note: The exemplary design in Figure 7 (b) does not provide special protection from sunlight as recommended in section 2.3 for the purpose of simplicity. Which sun protection features are necessary depends heavily on the placement of the SFA30 sensor module in the end product, the overall product design and certainly the application. Possible design options can be angled slot or hole patters of the apertures or a small shield above the aperture structure (see Figure 4 (a) and Figure 8).

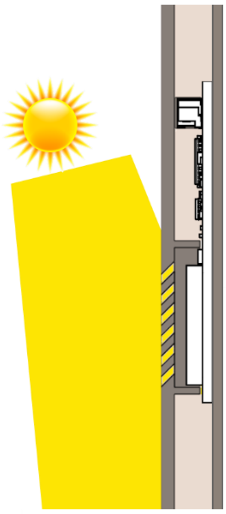

Figure 8: Cross-sectional view: sun protection through an angled aperture design.

An airtight sealing between the SFA30's PCB and the sensing elements' enclosing structure is required only for the most demanding applications combining highest performance requirements with a high possibility for different environmental conditions surrounding the SFA30 sensor module and outside the device. For such applications, an additional rubber seal or similar can be considered; even on the backside of the SFA30 sensor module around the sensing elements. However, special attention has to be paid to the chemical compatibility of the chosen sealing materials with the RHT sensor and the electrochemical cell (see section 4).

4 Exposure to Chemicals

The SFA30 formaldehyde sensor module and its on-board Sensirion SHT humidity and temperature sensor should be protected from volatile chemicals, in particular at high concentrations. Please also refer to the following two application notes for Sensirion's humidity and temperature sensors:

- SHTxx and STSxx Design Guide
- SHTxx Handling Instructions

Do not use materials for the device housing which outgas formaldehyde such as Polyoxymethylene (POM) for example. Otherwise, the formaldehyde gas emanating from this material will generate a high formaldehyde background at the sensor which may easily be dominant compared to the ambient formaldehyde concentration.

An easy check for formaldehyde (HCHO) outgassing is to place a sample of the material under test together with an SFA30 sensor module in a small container (use none-outgassing material only!) while reading the sensor's HCHO output. If the material is outgassing significant amounts of HCHO, the SFA30 sensor module will show an increase in the measured formaldehyde concentration, typically within one hour or less.

5 Important Notices

5.1 Warning, Personal Injury

Do not use this product as safety or emergency stop devices or in any other application where failure of the product could result in personal injury. Do not use this product for applications other than its intended and authorized use. Before installing, handling, using or servicing this product, please consult the data sheet and application notes. Failure to comply with these instructions could result in death or serious injury.

If the Buyer shall purchase or use SENSIRION products for any unintended or unauthorized application, Buyer shall defend, indemnify and hold harmless SENSIRION and its officers, employees, subsidiaries, affiliates and distributors against all claims, costs, damages and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if SENSIRION shall be allegedly negligent with respect to the design or the manufacture of the product.

5.2 ESD Precautions

The inherent design of this component causes it to be sensitive to electrostatic discharge (ESD). To prevent ESD-induced damage and/or degradation, take customary and statutory ESD precautions when handling this product.

5.3 Warranty

SENSIRION warrants solely to the original purchaser of this product for a period of 12 months (one year) from the date of delivery that this product shall be of the quality, material and workmanship defined in SENSIRION's published specifications of the product. Within such period, if proven to be defective, SENSIRION shall repair and/or replace this product, in SENSIRION's discretion, free of charge to the Buyer, provided that:

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- such defects shall be found, to SENSIRION's reasonable satisfaction, to have arisen from SENSIRION's faulty design, material, or workmanship;
- the defective product shall be returned to SENSIRION's factory at the Buyer's expense; and
- the warranty period for any repaired or replaced product shall be limited to the unexpired portion of the original period.

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6 Revision History

Date	Revision	Changes
November 2020	1.0	Initial version