Handling and Assembly Instructions

For SGPxx Gas Sensors

Preface

Sensirion SGPxx are gas sensors of high quality and are designed for high volume applications. They are therefore compatible with standard assembly and soldering processes. For taking advantage of their outstanding performance, some precautions must be taken during storage, assembly, and packaging. Therefore, please read the following instructions carefully – preferably during design-in phase and prior to production release of the respective device. Proper handling and choice of materials are crucial. Operating and storing sensors in the field under ambient environment is not critical.

1 Applicability

This document is applicable to all Sensirion SGPxx gas sensors.

2 ESD Protection

The sensor shall be protected from ESD (Electrostatic Discharge) and only be handled in ESD protected areas (EPA) under protected and controlled conditions (ground all personnel with wrist-straps, ground all non-insulating and conductive objects, exclude insulating materials from the EPA, operate only in grounded conductive floor, *etc.*). Protect sensors outside the EPA using ESD protective packaging.

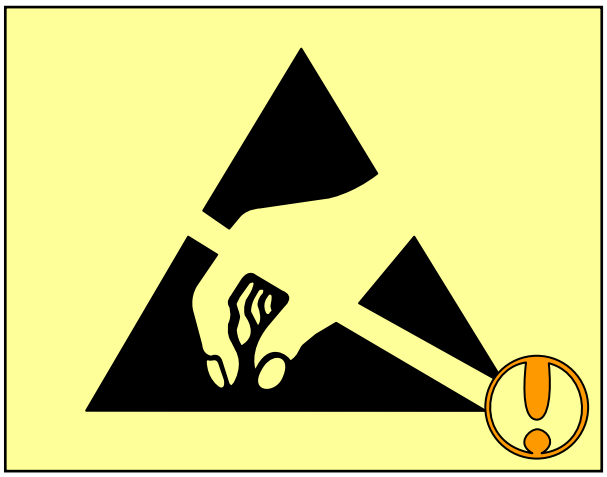

Figure 1 Protection against ESD is mandatory.

3 Exposure to Chemicals

Ensure good ventilation and fresh air supply to avoid accumulation of any chemicals.

SGPxx are highly sensitive environmental sensors and as such they are not ordinary electronic components. Opening of the original package exposes the sensors to the given environmental conditions and makes them susceptible to pollutants. While applying sensors in the field in ambient environment is not critical, pollutants are known to occur in manufacturing environments, by outgassing from contaminating materials, and/or during storage. Please carefully follow the guidelines in these instructions to ensure that you can benefit from the outstanding performance of the SGPxx gas sensors.

The sensors shall not get in close contact with pure volatile chemicals such as solvents or other organic compounds. Especially high gas concentrations and long exposure to them during storage must be avoided. Volatile organic compounds cover classes such as ketones (*e.g.,* acetone), aldehydes (*e.g.,* formaldehyde), alcohols (*e.g.,* ethanol), aromatics (*e.g.,* toluene), esters (*e.g.,* glycol ester), *etc.*

Please note that such chemicals are integral part of many epoxies, glues, adhesives, *etc.* and they may outgas during baking and curing. These chemicals are also added as plasticisers into plastics, used for packaging materials, and do outgas for some period.

Acids and bases may affect the sensor irreversibly and shall be avoided: HCl, H_2SO_4, HNO_3, NH_3, acetic acid, *etc.* Also oxidizing gases such as ozone (O_3), nitrogen dioxide (NO_2), and H_2O_2 in high concentration should be avoided. Organic nitrogen compounds such as amines (*e.g.*, ethylenediamine, formamide, *etc.*) in the presence of humidity can irreversibly contaminate SGPxx sensors. Such substances can outgas from materials used for PCB and device design, for instance, conformal coatings, plastics, and rubber sealings. Please note that the examples listed above do not represent a complete list of harmful substances.

Be particularly careful when using strong cleaning agents (*e.g.*, detergents, alcohols, brominated or fluorinated solvents). Cleaning any part of a product might lead to high concentration of cleaning agents on the sensor resulting in permanent drift or complete breakdown of the sensor. Please remove any sensors or devices containing sensors before cleaning the production area and tools. Ensure good ventilation (fresh air supply) during production and after cleaning with cleaning agents.

4 Packing and Storage

Always store SGPxx gas sensors in originally sealed ESD bags and preferably under dry conditions until final use.

SGPxx gas sensors need to be stored with care. To avoid accumulation of harmful gases that might settle on the sensing layers, it is recommended that the manufacturing environment is well ventilated. Prior to assembly or use of the sensors it is strongly recommended to store the sensors in the original sealed ESD bag.

Once the sensors have been removed from the original ESD bag we recommend to store the individual sensors as well as devices with assembled sensors in sealed metal-in antistatic shielded ESD bags, preferably under vacuum, in an environment of inert gas (like N_2) or synthetic air meeting the requirements for temperature and relative humidity as detailed under *Recommended Operating and Storage Conditions* in the corresponding datasheet of the SGPxx product. If the presence of contaminating gases (see *3 Epxosure to Chemicals*) cannot be excluded it is strongly recommended to store the sensor under dry conditions (*e.g.*, in a dry cabinet or by adding a silica gel pack to the closed ESD bag). In particular, it is recommended not to use any adhesive or adhesive tapes to reseal the sensor bag after opening. Recommended ESD bags (no polluting effect on SGPxx sensors) are given in the table below.

ESD bag	
Manufacturer	Product
Stroebel	«topdry EMI» bags

Sensors as components or mounted into the final product shall not be packaged in outgassing plastic materials which could cause sensor pollution. Besides metal-in antistatic shielded ESD bags, paper or cardboards based packaging, deep drawn plastic trays (PE, PET, PP) may be considered. Do not use antistatic polyethylene bags (light blue, pink or rose color); be very careful with bubble foils and foams.

Be careful with stickers located inside the packing (*e.g.*, on the housing of the device). Sticker size should be kept to a minimum, and the sticky side shall fully adhere onto a surface.

Please note that many packaging materials may be provided with additives (plasticizers) which may have a polluting effect on the sensor. Generally speaking, if a material emits a strong odor you should not use it. Such additives may also be added to materials which are listed for recommended use herein. For high safety, Sensirion recommends to qualify device housing and shipment packaging in simulated shipping test.

5 Pick-and-Place Process

Avoid mechanical contact during pick-and-place process at the sensor center.

Standard pick-and-place equipment for QFN packages may be used for handling. The center part of the sensor is very sensitive to any mechanical impact and any contact must be prevented. The inner diameter of the pick-and-place nozzle must be sufficiently large to ensure (under consideration of maximum pick-up offsets) that the nozzle will not be in mechanical contact with the central part of the sensor package with a diameter of 1.5 mm. In particular we recommend a pick-and-place nozzle having an opening with inner diameter larger than 2 mm.

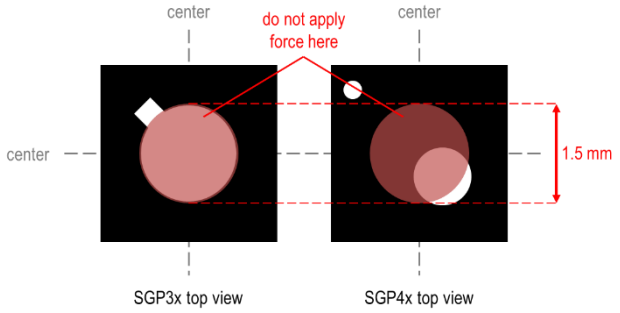

Figure 2 Areas of the sensor suitable for application of force during mounting process. Force must only be applied outside the red area.

The surface of the tool that touches the module outside of the center area should be flat and smooth. Pick-and-place forces should not exceed 4 N during downward placement.

6 Water & Dust Protection Membrane

Water and dust protection membrane must not be removed, damaged or altered in any way.

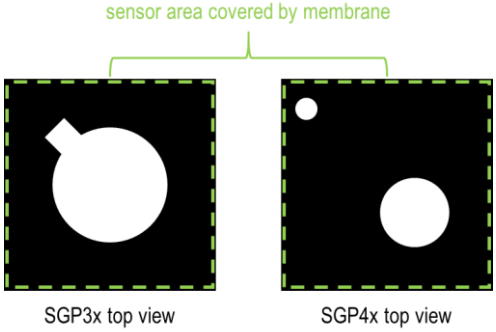

Figure 3 The dust protection membrane completely covers the SGPxx sensor surface.

The SGPxx gas sensor is equipped with a water and dust protection membrane that is directly attached to the sensor. The membrane completely covers the sensor opening (see

Figure 3) and thus acts as a shield against pollution from spray water and dust. The membrane is completely permeable to all target gases the SGPxx is intended to measure. Therefore, the water and dust protection membrane must not be removed, damaged, or altered in any way to ensure reliable operation of the SGPxx gas sensor.

7 Assembly

No mechanical force shall be applied to any part of the sensor during assembly or usage. Use gloves or finger cots while assembling the SGPxx.

7.1 Soldering Instructions

Follow the recommended standard soldering procedure during assembly.

Sensors in SMT packages such as Sensirion SGPxx gas sensors are classified as Moisture Sensitivity Level 1 (IPC/JEDEC J-STD-020). It is recommended to process the sensors within 1 year after date of delivery.

Standard reflow soldering ovens may be used for soldering. The sensors are designed to withstand a soldering profile according to IPC/JEDEC J-STD-020 with a recommended peak temperature of 245 °C during up to 30 s for Pb-free assembly in IR/Convection reflow ovens (see **Figure 4**). In addition, we strongly advice a maximum ramp-down rate of <4 °C/s. Make sure that maximum temperatures and exposure times are respected. In case the PCB passes through multiple solder cycles (as is the case for, *e.g.*, PCBs that are assembled on top and bottom side), it is recommended to assemble the SGPxx only during the last solder cycle. This is to reduce risks of sensor pollution.

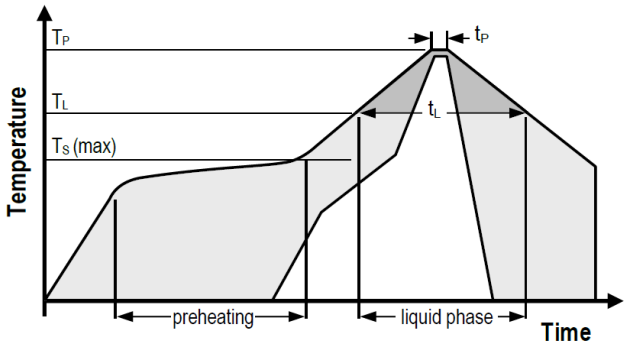

Figure 4 Soldering profile according to JEDEC standard. Recommended parameters are detailed in the table below.

It is recommended not to use vapour phase soldering to avoid potential contamination of the sensor. The use of "no clean" type 3 solder paste is recommended. [1] An appropriate amount of solder paste shall be used to achieve a stand-off height (clearance between the package body and any part of the substrate) of 50–75 µm. Please consult the appropriate sensor data sheet for device specific information on metal land patterns and recommendations on solder paste printing stencils.

Recommended conditions during soldering			
Phase	Temperature	Ramp	Time
Liquid phase	T_L < 220 °C	–	t_L < 150 s
Ramp-up	–	<3 °C/s	–
Peak	T_P = 245 °C	–	t_P ≤ 30 s
Ramp-down	–	<4 °C/s	–

Board wash shall be avoided for Sensirion SGPxx gas sensors and it is therefore recommended to use a "no-clean" solder paste. In addition, we recommend *not to use ultrasonic cleaning* since it could result in damage of the sensor. If a board wash is a requirement for the final product or application, the corresponding wash process needs to be properly qualified in order to prove compatibility with the SGPxx gas sensor.

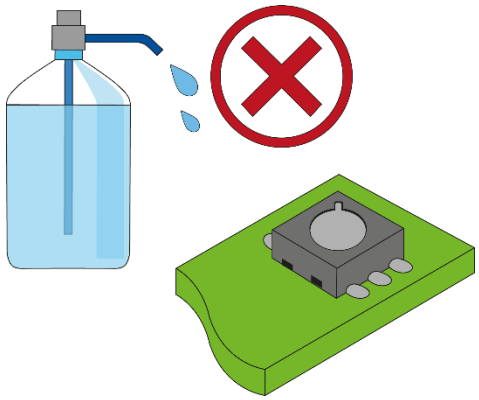

Figure 5 Do not apply board wash to PCBs containing SGPxx sensors.

We recommend *not to manually solder* the Sensirion SGPxx gas sensor since corresponding process parameters may not be controlled well and it could result in a damage of the sensor. In particular, hot air with an air temperature above 250 °C on the device surface should be avoided. Since the sensing element has a very low thermal mass, it heats up to the air temperature very quickly.

It is important to note that the side faces of the I/O pads may oxidise over time. Therefore, a solder fillet may or may not form.

For application in corrosive environment – such as condensed water or corrosive gases – it may be necessary to protect the electronic assembly including the soldered contacts of the sensor with a passivation. Such passivation may be achieved by conformal coating or by applying adhesive.

[1] Solder types are related to the solder particle size in the paste: Type 3 covers the size range of 25–45 µm as specified in IPC J-STD-005A.

7.2 Conformal Coating

Low viscose conformal coatings or potting materials may flow onto the sensor, cover the sensor element and thus render the gas sensor dysfunctional. Ensure that nothing is (even partly) covering the dust protection membrane of the sensors. Do not protect/cover the top surface with tape as this may harm the dust protection membrane.

Use recommended conformal coatings, avoid outgassing by curing and avoid covering of the sensor top surface.

Make sure that the employed conformal coating material is not outgassing volatile organic compounds (*e.g.*, aromatics) or organic nitrogen compounds (*e.g.*, amines) that will outgas in the final application in order not to compromise the sensor reading.

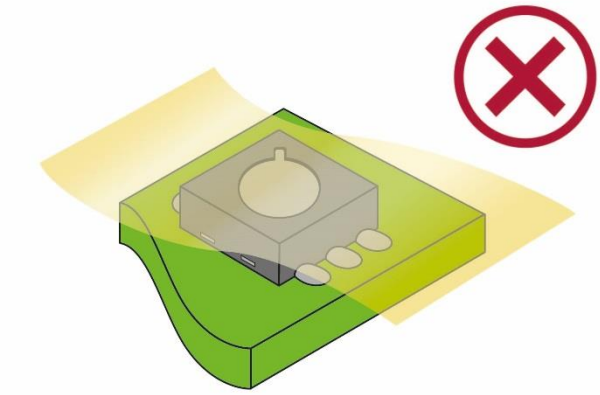

Figure 6 Do not put tape directly on the sensor.

Do not use silicone-based conformal coatings. Sensirion tested and recommends the conformal coatings listed in the table below which are known to be suitable if applied and fully cured under good ventilation (fresh air supply) and according to respective datasheet.

Conformal coating	
Manufacturer	Product
Chase	Humiseal 1B73EPA
Peters	Elpeguard SL 1301 ECO-FLZ
Electrolube	AFA (Aromatic Free Acrylic Conformal Coating)

The SGPxx gas sensor is highly sensitive to small ambient gas concentrations. Therefore, it has to be ensured that the conformal coating is not outgassing to avoid unwanted gas concentrations around the sensor. Drying conformal coatings for 24 h at room temperature and additional baking for 5 h at 80 °C has been tested and leads to reduced outgassing. Depending on the type and amount/thickness of coating, longer baking time might yield even better results. However, baking temperature should not exceed 85 °C. In any case, ensure good ventilation throughout the application, staging and curing to prevent sensor pollution.

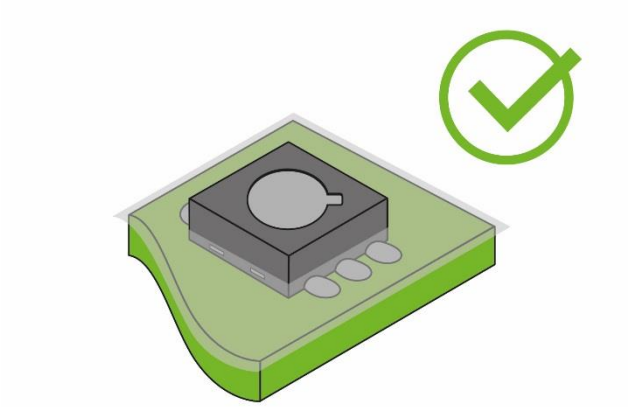

Figure 7 If conformal coating is applied, the top surface of the sensor must remain free of coating.

In order to ensure a homogeneous baking it is essential to have the thinnest possible coating and avoid accumulation of the fluid material in gaps and voids on the PCB.

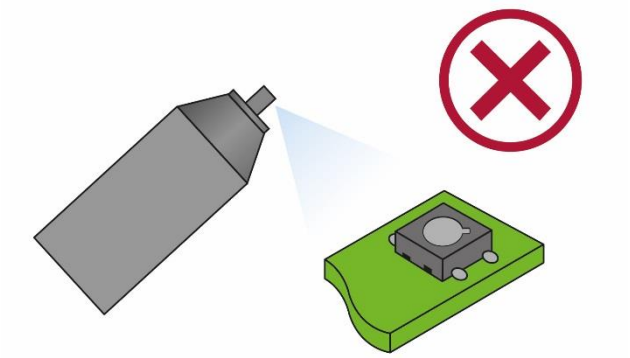

Figure 8 Do not spray onto sensor.

7.3 Adhesives and Encapsulants

Use recommended adhesive and encapsulant materials.

Regarding adhesives and encapsulants the materials in the following tables have been tested and may be used – according to respective datasheets, applied and fully cured in well ventilated environment (fresh air supply). Other materials than the ones listed below might also be used, however they were not tested and thus are not recommended.

Epoxy adhesives	
Manufacturer	Product
EPO-TEK	H70S

The sensor shall be mounted into the final product, if possible, after all materials that are used in the assembly process have completely cured, outgassed or dried out.

Otherwise ensure good ventilation (fresh air supply) in curing ovens and assembly lines.

Other recommended materials	
Manufacturer	Product
	Teflon
	PEEK
	Polycarbonate (PC)
	ABS
	FR4 PCB
	Viton seals (after thermal outgassing)
3M	Kapton (polyimide) tape
	Polyethylene

7.4 Handling after Assembly until Final Use

Seal the device housing by a recommended adhesive after assembly.

In order to protect the SGPxx gas sensor during shipment, it is strongly recommended to seal the cavity of the housing in the device where the sensor is placed in by one of the recommended adhesives (see above) until its final use by the end-customer. The adhesive must not touch the dust protection membrane of the SGPxx. It must be ensured that the cavity itself is not outgassing any polluting agents as detailed in Section 3 Exposure to Chemicals and Section 8 Application in Extreme Environments.

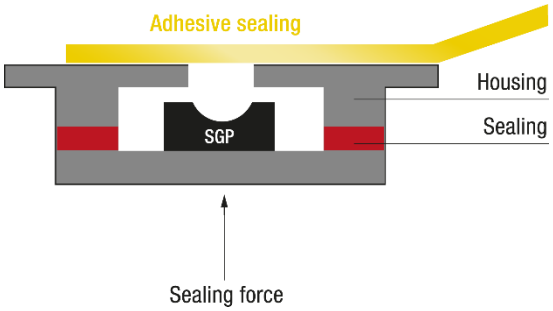

Figure 9 Cover the device cavity where the SGPxx is located by a recommended adhesive during shipment until final use as well as during rework and repair.

7.5 Rework and Repair of Final Devices

Handling instructions also apply during repair and rework of assemblies.

Ensure that recommendations in these instructions are equally considered during repair and rework of assemblies containing the SGPxx gas sensor. The replacement of SGPxx gas sensors requires another reflow soldering step. During repair and rework it may be recommendable to cover the opening of the cavity within the device where the SGPxx is placed in with kapton tape (specific recommendation see above).

8 Application in Extreme Environments

Some applications require the exposure of gas sensors to harsh environments. In many cases, this is uncritical for the use of the SGPxx. However, some precautions must be taken.

For exposure to extreme conditions with regards to humidity and temperature please consult the datasheet of the respective product. Please make sure that exposure time of the sensor to the maximum range of operating conditions is limited. Limits are provided in the corresponding data sheet. Exposure to volatile organic compounds at high concentration and long exposure time is critical not only in assembly but also in the field. Such applications need to be carefully tested and qualified.

Exposure to acids (pH < 6) or bases (pH > 8) may be critical, too. Critical concentrations are typically concentrations high enough to attack polymers. Etching substances such as H_2O_2, NH_3, *etc.* at high concentration are critical to the sensor, too. Exposure to organic nitrogen compounds such as amines can lead to irreversible drift of the sensor even at small concentrations in the ppm range and must be thus avoided.

Corrosive substances at very low concentrations are not critical to the sensor itself. However, they may attack the solder contacts. Therefore, the contacts must be well protected (passivated) in case of an application to such environment – compare also Section 7 Assembly.

Application of Sensirion SGPxx sensors to harsh environments must be carefully tested and qualified. Sensirion qualifies its SGPxx sensors to work properly within ambient clean air – qualification for use in harsh environments is duty of the user of the sensor.

9 Disclaimer

The above given restrictions, recommendations, materials, *etc.* do not cover all possible cases and items. Material recommendations are provided regarding pollution of SGPxx gas sensors and assume optimally sealed storage conditions – the materials were not tested regarding other properties like reliability, performance, usability or mechanical properties. The material recommendations have been compiled with our best knowledge at the time of writing. Manufacturers may change the compounds without notice, which can lead to reduced sensor performance due to outgassing. This document is not to be considered complete and is subject to change without prior notice.

Revision History

Date	Version	Changes
April 2018	1.0	–
May 2020	1.1	Total revision
November 2020	1.2	More detailed description of pollutants added to all sections. Section 4: recommendations for packing and storage adapted. Section 5: visualization of SGP4x added to Figure 2. Section 6: visualization of SGP4x added to Figure 3.

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