SENSIRION

Handling Instructions

For SHTxx Humidity and Temperature Sensors

Sensirion's relative humidity and temperature sensors SHTxx (where xx serves as placeholder) offer best in class performance in a broad range of applications. To ensure optimal performance, it is important to follow certain guidelines during storage, assembly, and packaging. This document should be reviewed during the design-in phase and before production release. Special attention should be paid to avoiding exposure to volatile organic compounds (VOCs) in high concentrations and/or for long periods of time, particularly during manufacturing and storage. Therefore, proper handling to mitigate any risks and correct material selection is crucial to ensure highest performance.

Key Instructions

- Protection against ESD is mandatory.
- Do not use polyethylene antistatic bags.
- Do not apply board wash.
- Do not apply spray to an unprotected sensor.
- Avoid exposing the sensor to VOCs.
- Avoid exposure to cleaning agents.
- Cover the sensing element during coating.

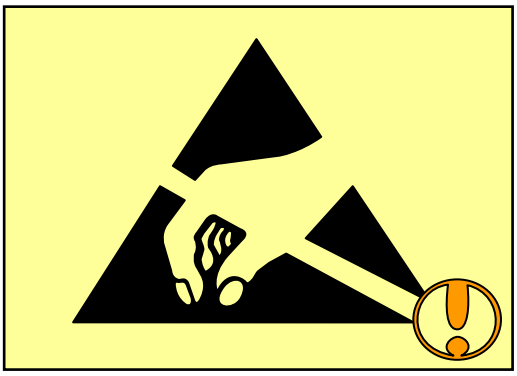
This document is applicable to all Sensirion SHTxx humidity and temperature sensors.

Contents

1 General

1.1 ESD

To ensure proper functioning of the sensor, it must be always protected from Electrostatic Discharge (ESD). Handling of the sensor should take place exclusively in Electrostatic Discharge Protected Areas (EPAs) that have been properly set up to minimize the risk of ESD. This includes grounding personnel with wrist-straps or similar measures, grounding all conductive objects and excluding insulating materials from the EPA. Additionally, all operations should be conducted on a grounded conductive floor. To further protect the sensor, it should be packaged using ESD protective materials when not being handled within an EPA.



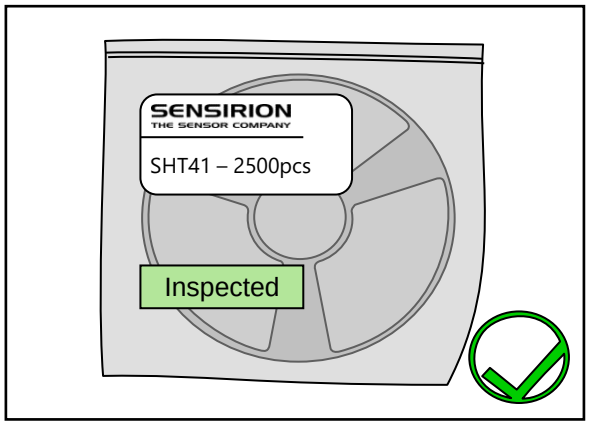
Instruction 1. Protection against ESD is mandatory.

1.2 Storage

To ensure optimal performance of the sensors, we recommend storing them in the original sealed ESD bag prior to assembly. The ideal storage conditions for the sensors are as follows:

- Temperature: 10 °C-50 °C (0…125 °C for a limited time)
- Humidity: 20-60 %RH (sensors that are not stored in ESD bags).

These guidelines ensure that the sensors are in optical condition for assembly and use.



Instruction 2. Store sensors in original, unopened ESD bag.
Place additional stickers only on the outside of the ESD bag.

To ensure longevity and accuracy of the sensors, it is recommended to store them in metal-in antistatic shielded ESD bags once they have been removed from their original packaging. This will help protect the sensors from electrostatic discharge and other external influences.[1]

[1] This recommendation also applies to devices with assembled sensors.

Additionally, it is recommended to not use any adhesive or adhesive tapes to reseal the sensor bag after opening. This can help avoid contamination and ensure integrity of the sensor. The ESD bags listed in **Table 1.** ESD Bag compatibility are recommended for this purpose.

Manufacturer	Product
Stroebel	Topshield Bags

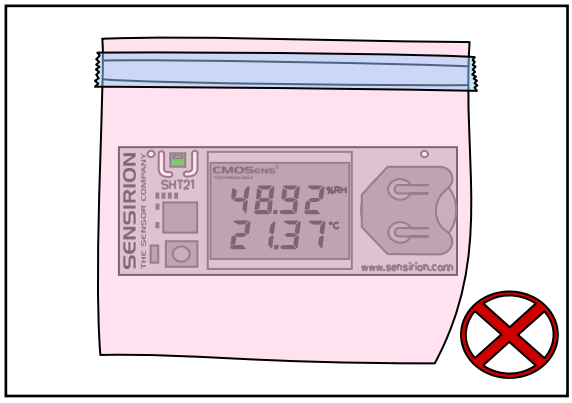
Table 1. ESD Bag compatibility, the validity of these recommendations might change without prior notification if the manufacturer changes the formulation of the product.

When packaging sensors, it is important to ensure that the materials used are not a potential cause of sensor pollution. To ensure the accuracy and longevity of the sensors, only use packaging materials that do not contaminate the sensor or are recommended by our specialist team.

Metal-in antistatic shielded ESD bags, paper or cardboards based packaging, and deep-drawn plastic trays such as PE, PET, and PP may be considered. Do not use antistatic polyethylene bags, bubble foils, and foams, as they may contaminate the sensor. Additionally, caution should be used when using stickers inside the packaging, as they may also cause contamination. Sticker size should be minimized, and the sticky side should be fully adhered to the bag surface.

It is important to note that many packaging materials contain additives (plasticizers) that negatively impact the sensors' performance. As a rule, if a material emits a strong odor, it should be avoided. Additionally, some recommended materials can contain pollutant additives depending on the brand, so it is important to be aware when selecting packaging materials.

To validate the storage material, we recommend conducting a qualification test on the final device housing and shipment packaging[2]. The test should include exposing the device with the sensor inside the shipment packaging to a temperature ≥65 °C for at least 168 hours. This test simulates long exposure times by increasing the kinetics of the contamination behavior. If shipping or storage conditions are expected to be harsh, the qualification test conditions for the packaging material should be tuned. If the packaging is compatible, the sensor reading should show no deviation from a reference compared to the same measurements taken before the exposure.



Instruction 3. We do not recommend using polyethylene antistatic bags.
We do not recommend using adhesive tapes inside packaging.

For guidance on testing Sensirion humidity sensors, consult the "Testing Guide for Humidity Sensors" [1]. This guide provides instructions to assess the sensors' performance. In case of having any doubt, contact Sensirion's support line.

[2] Especially for harsh shipping conditions.

1.3 Exposure to chemicals

Humidity and temperature sensors require special care to ensure optimal performance. The sensors can be polluted, and the exposure to volatile chemicals, acids, bases and cleaning agents should be minimized. Some chemicals can cause sensors to drift, irreversibly in some cases. Among these chemicals are Ketenes, Acetone, Ethanol, Isopropyl Alcohol, Toluene, for example[3]. Guidelines to ensure the sensors maintain their performance are outlined below:

- Avoid exposing the sensor to volatile chemicals such as solvents or organic compounds. High concentrations and long exposure can cause inaccuracy in the humidity reading or even irreversibly damage the sensor. Some of these chemicals are included in solvents, cleaning solutions, and detergents, *e.g.* ethanol, isopropanol, methanol, acetone, *etc.*.
- Certain chemicals, often found in epoxies, glues, adhesives, and plastics, can outgas during baking and curing, potentially affecting the sensor.
- Avoid exposure to acids and bases or highly reactive chemicals in general, as they can irreversibly damage the sensor. This includes among others HCl, H_2SO_4, HNO_3, NH_3, H_2O_2 or high concentrations of ozone.
- Avoid contact with cleaning agents, such as when washing the PCB after soldering, or strong air blasts from an air-pistol[4], as they can cause drift in the reading or complete breakdown of the sensor.
- Good ventilation helps to avoid harm to the sensor by preventing concentration buildup of volatile chemicals.

2 Assembly

The sensors can be soldered using standard reflow soldering ovens. They are designed to withstand the soldering process, including the profile according to IPC/JEDEC J-STD-020 with peak temperatures at 260 °C for up to 30 seconds during Pb-free assembly in IR/Convection reflow ovens (see **Figure 1**).[5]

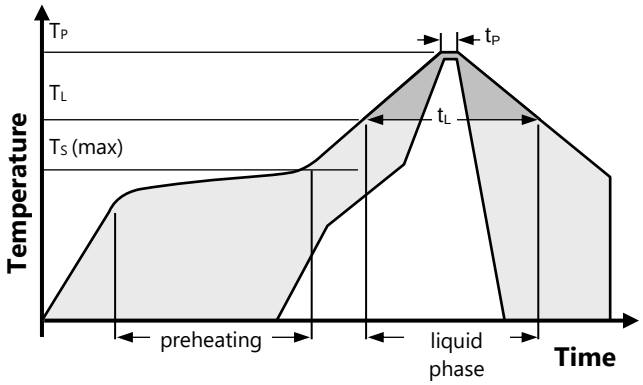


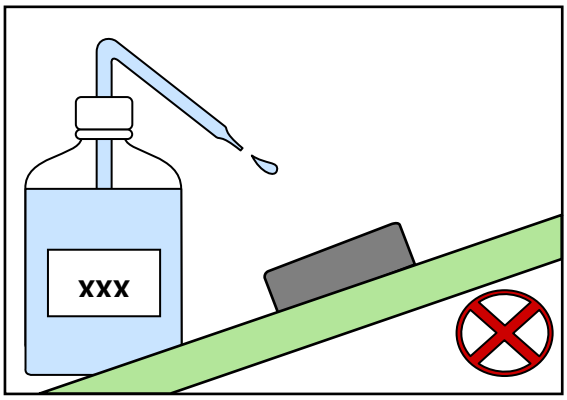
Figure 1. Soldering profile according to JEDEC standard. $T_P \leq 260$ °C and $t_P \leq 30$ sec above 255 °C for Pb-free assembly. $T_L < 220$ °C and $t_L < 150$ sec. Ramp-up rate <3 °C and ramp-down rate <6 °C/sec for temperatures $>T_L$.

[3] Such chemicals are integral part of epoxies, glues, adhesives, etc. and outgas during baking and curing. These chemicals are also added as plasticisers into plastics, used for packaging materials, and do out-gas for some period. Please note that this is not a complete list of harmful substances, and it is important to carefully read the application notes and follow all the guidelines provided to ensure optimal performance of the sensor.

[4] Oil free air does not cause any harm to the sensor.

[5] Vapor phase soldering may not be recommended for the assembly of this specific product. If no alternative options are available, it is advised that the end-user or a qualified party conducts a compatibility qualification. Please note that the compositions of heat transfer liquids can vary among manufacturers, and therefore Sensirion cannot provide specific information regarding their use in vapor phase soldering.

When soldering humidity sensors, it is important to ensure that the maximum temperatures and exposure times are respected to prevent damage to the sensors. If the PCB goes through multiple solder cycles, we recommend assembling in the last solder cycle to reduce the risk of sensor pollution[6]. The use of "no clean" type ≥3 solder paste[7] is strongly recommended as it eliminates the need for a board wash, which can be harmful to the sensors.



Instruction 4. Do not apply board wash.

It is important to use the appropriate amount of solder paste to achieve a stand-off height[8] of 50-75 µm. Corresponding sensor datasheet provide detailed information on the metal land pattern and recommendations on solder paste printing stencils. Standard pick & place equipment and vacuum nozzles for standard QFN packages can be used for assembly of SHTxx sensors.

Manual soldering is not recommended, and rework soldering should be limited to five seconds at up to 350 °C. Additionally please note that after exposure to high temperatures, such as during reflow soldering, humidity sensors may temporarily read a negative humidity offset, typically between -1...-2 %RH. This offset will disappear by itself when the sensor is exposed to ambient conditions, typically within one to three days. If humidity testing is performed immediately after reflow soldering, this offset should be considered when defining the test limits.

It is important to note that the diced edge or side faces of the I/O pads may oxidize over time, so a solder fillet may or may not form. Therefore, there is no guarantee for solder joint fillet heights of any kind.

Sensors in SMT packages are classified as Moisture Sensitivity Level 1 (IPC/JEDEC J-STD-020), meaning that it is recommended to process the sensors within 1 year of the date of delivery to ensure optimal performance. Before beginning the assembly process, it is important to carefully read the User's Guide and Datasheets to ensure proper handling and usage of the sensors.

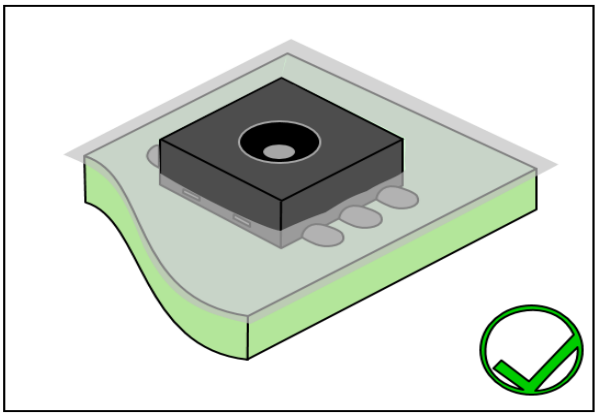
It is important to note that no mechanical force should be applied to any part of the sensor during assembly or usage to prevent damage.

To protect electronic assemblies, including soldered contacts of sensors, in corrosive environments such as condensed water or corrosive gases, a passivation layer should be applied. This can be done through conformal coating or an adhesive. However, it is important to use high viscous conformal coatings or potting materials to avoid flowing into the sensor opening and covering the sensing element, rendering the humidity sensor inoperable. Alternatively use the Sensirion solution with protective cover. Additionally, the sensor opening must remain uncovered and free of any coating to ensure optimal performance.

[6] Max. 3 solder cycles per sensor.

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

[8] Clearance between the package body and the substrate.



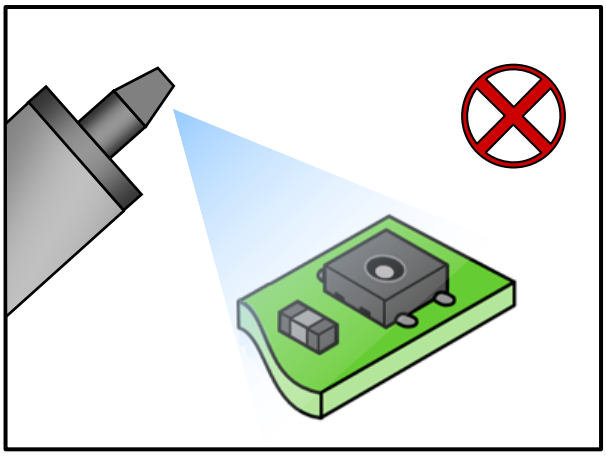
Instruction 5. If conformal coating is applied, the top surface of the sensor must remain free of coating.

When applying conformal coatings to electronic assemblies, it's important to consider that solvent vapors are produced during the curing and processing of the coating. Proper ventilation should be established throughout the application, staging, and curing process to prevent pollution of the sensor. This can be achieved by using ovens with fresh air supply, to ensure that the concentration of these gaseous substances remains low.

Always follow the manufacturer's guidelines for coating thickness and curing times and use the maximum provided time value before assembling the sensor. This is especially important if the PCB design features large components with undercuts, where high layer thicknesses on/under components or drain-off edges can form. Tack-free state of the coating is not an indication of full curing; full curing state corresponds to the manufacturer's indication. It is also important to ensure process stability for coating thickness and apply corresponding safety margins for curing times. A non-exhaustive list of compatible conformal coatings can be seen on **Table 1**.

Manufacturer	Product
Humiseal	1B51NSLU
Dowsil	1-2620 Conformal coating
Dowsil	1-2577 Conformal coating
Chemtronics	UR-101 Conformal Coating
Loctite	3900 Conformal Coating

Table 2. List of conformal coatings compatible with the SHTxx humidity sensor and are suitable if applied and fully cured with good ventilation and according to the respective datasheet. The validity of these recommendations might change without prior notification if the manufacturer changes the formulation of the product.

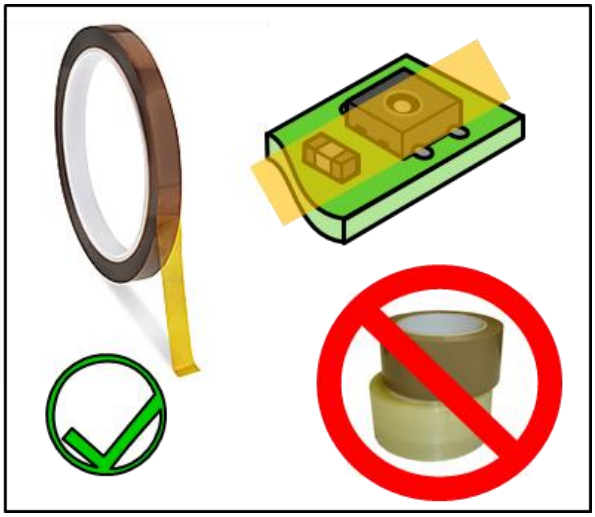


Instruction 6. Do not apply spray to unprotected sensors.

When using spray coating techniques, including applying varnish or conformal coatings, we recommended using the SHT4x sensor with the removable protective cover. The cover ensures no contaminant interacts with the sensing element. When using tapes instead of the suggested protective cover, please use only the suggested tapes listed in **Table 3**.

Manufacturer	Product
3M	Kapton® Electrical Tape 92
3M	Tissue Tape
Nitto	DAF Tape EM-310
Tesa	HAF 58470

Table 3. List of tapes which are tested and are suitable for processes in contact with SHTxx sensors. This list is not exhaustive and other compatible materials might be found.



Instruction 7. In conjunction with the sensor, use only recommended the tapes listed in **Table 3**, as other tapes could contaminate the sensors. This compatibility might change in the future, and it is valid as of 2023.

Adhesives usually contain contaminating materials that can outgas. When used in conjunction with sensors and in PCB assembly, outgassing should be assessed. **Table 4** lists the materials compatible with the sensor. The listed materials show no contamination when applied and fully cured in a well-ventilated environment with fresh air supply. Be cautious when using different materials or brands that are not listed in the tables, as they may be harmful, even if they should be the same type of material. Always test the materials carefully before use. Please note that these recommendations are based on tests of the commercialized products as of 2023. The compatibility might change without prior notification as manufacturers can change formulations.

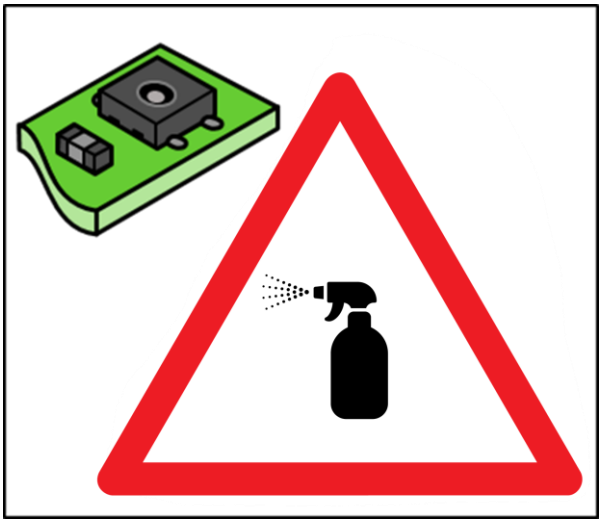
Manufacturer	Product	Type
Araldite	DBF-DB	Adhesive
MXBON	MXBON 22460	Adhesive
Delo	Monopox DA255	Adhesive
Delo	Dualbond BS3770	Adhesive
Loctite	5060H	Adhesive
Loctite	Ablestik 6202C	Adhesive
Jowat	Jowatherm 262.95	Hot Melt Adhesive
Silco Inc	Sil-Bond 4500	Silicone Adhesive
Coll Tech	N-SIL8113	Silicone Adhesive
ISO-Elektra	ISO-PUR K760	Resin

Table 4. List of some of the known compatible materials with SHT4xx. This is not an exhaustive list and may change without prior notice.

Even if the materials do not contaminate the sensors, materials such as hot melts can absorb moisture. Consequently, the sensor response time might be increased. Therefore, hot melts, common 3D printing materials and in general moisture absorbing materials should be used prudently.

To prevent contamination in assembly lines the following measures should be taken:

- We recommend placing the sensor on the assembled device only after all components are fully assembled and chemicals are completely cured or dried.
- Dust or particles entering the sensor opening can impact its performance. Therefore, it is advisable to wear clean gloves or finger cots while handling the sensor and take preventive measures to minimize particles in the assembly line.
- During repair and rework, it is recommended to cover the sensor with tape, following the recommendations in **Table 3**.
- The user should be cautious when using potent cleaning agents, such as detergents, alcohols, brominated or fluorinated solvents, as cleaning any part of the product can result in a high concentration of cleaning agents on the sensor.
- Good ventilation helps prevent any solvents that have evaporated stay in contact with the sensor.



Instruction 8. Prevent sensor from exposure to cleaning agents.

3 Operation in the Field

When operating a capacitive humidity sensor in the field, there are generally no impairments to its performance if the design is good, see Design-In Guide [2]. However, exposure to chemicals and other contaminants can lead to degradation of the sensor's accuracy over time. In sections 1.3 and 2 some examples of compatible and harmful chemicals can be seen.

Humidity sensors work by measuring change in the dielectric constant due to water absorption. The deviation in the reading due contaminants occurs as contaminants induce a change in the dielectric constant of the sensing material. As the sensor cannot distinguish if the induced dielectric constant change comes from contaminants or water molecules, they distort the measurement. Water content in the sensor decreases as the humidity of the environment decreases. For some contaminants, this is not the case, as they adhere strongly and become troublesome to remove from the system. The strong binding of contaminants can lead to an irreversible drift in the sensors reading.

To mitigate the contamination induced drift, the latest generation Sensirion humidity sensors are equipped with a heater. The heater helps reversing the contaminant effects by heating itself and forcing contamination desorption. Please note that some contaminants have a more severe impact on the sensor's accuracy than others, so it is crucial to consider the environment in which the sensor will be operating when selecting the design.

The contamination drift should not be confused with the reversible creep sensors used at extreme conditions[9] experience [3]. To ensure minimal drift, please follow the guidelines and protocols in the dedicated document to Creep Mitigation forSHT4x [3].

4 Extreme Conditions and Reconditioning

Certain applications require the exposure of sensors to extreme conditions. The exposure time and conditions of the sensor should be within the maximum specified in the product datasheet.

Exposure to high concentrations of organic compounds during prolonged periods can also be critical both during assembly and operation of the sensor. Applications with such exposures should be thoroughly validated. As general guidance, the higher the concentration and reactivity of the chemicals the higher the chances of negatively affecting the sensor's performance.

Corrosive substances in low concentrations are not detrimental to the sensing element. However, they may corrode the soldered contacts. Hence, the contacts must be well-protected (passivated) in corrosive environments – see also Section 2.

- The exposure of Sensirion's SHT sensors to severe conditions must be tested and validated. Sensirion qualifies its humidity and temperature sensors to function appropriately in ambient conditions. The user is responsible for qualifying the sensors for applications in contact with potentially harmful substances. As sometimes exposure to extreme conditions is unavoidable, the following reconditioning procedure is suggested to restore sensor performance: Baking: from 100 to 105 °C at <5 %RH for 10 h
- Re-Hydration: from 20 to 30 °C at ~75 %RH for 12 h

For the re-hydration procedure, a solution of saturated NaCl can be used. For exact indications, please refer to the "humidity fixed points of binary saturated aqueous solutions" [4].

[9] High temperature and relative humidity above 90%.

5 Removable Protective Cover

When handling the removable protective cover, some visual anomalies may be noticeable. Removing the cover might leave adhesive residues on the sensor's top surface. Such visual artifacts do not affect the sensor's functionality.
It can also occur that the anti-adhesion layer, highlighted in **Figure 2**, contracts during high-temperature processes, such as reflow soldering. The shape distortion only occurs to the anti-adhesion layer, while the protective cover remains unaffected. Therefore, after removal no effect should be noticeable.

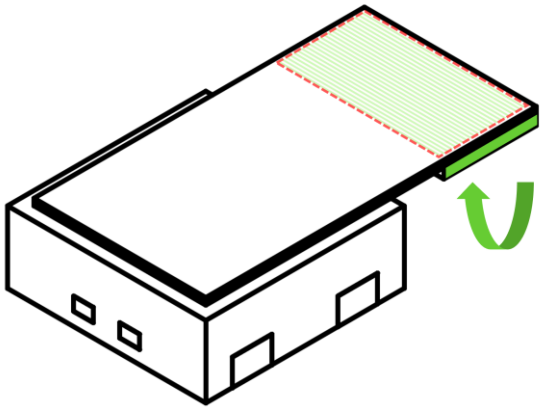


Figure 2. Visualization of the anti-adhesion layer of the protective cover.

After a coating process residues may be found on the edges of the sensor packaging, even after removal of the protective cover, and particularly when depositing thick layers. The sensor with a protective cover should not be loaded into the machine in bulk (Schüttgut). Do not remove the sensors from the reel and place them in a dispenser container, as they could get tangled or stick together. Instead, feed each sensor individually and directly from the reel into the machine.

6 Bibliography

[1] Sensirion, "Sensors Specification Statement and Testing Guide," 19 April 2021. [Online]. Available: https://sensirion.com/products/downloads/.

[2] Sensirion, "SHTxx Design Guide," [Online]. Available: www.sensirion.com.

[3] Sensirion, "Creep Mitigation SHT4x," 04 2022. [Online]. Available: https://sensirion.com/media/documents/A88858C9/629626D4/Application_Note_Creep_Mitigation_SHT4x.pdf.

[4] L. Greenspan, "Humidity Fixed Points of Binary Saturated Aqueous Solutions," *J Res Natl Bur Stand A Phys Chem,* vol. 81A(1), no. doi: 10.6028/jres.081A.011. Epub 1977 Feb 1. PMCID: PMC5295834., pp. 89-96, 1977.

[5] IEEE, "IEEE Reference Guide," 2018. [Online]. Available: https://ieeeauthorcenter.ieee.org/wp-content/uploads/IEEE-Reference-Guide.pdf. [Accessed 20 1 2023].

7 Disclaimer

The beforementioned restrictions, recommendations, materials, are not an exhaustive list of all possible cases and items.

The material recommendations provided refer to the SHTxx sensors and assume ideal processing for averting VOC in the process – the materials were not tested regarding other characteristics such as dependability, efficacy, usefulness, or mechanical properties. Material recommendations are made based on the latest knowledge possessed at the time of writing. Manufacturers may alter compounds and formulations without warning, which can lead to inaccuracies in the recommended materials. This document is not comprehensive and is subject to change without prior notification.

8 Revision History

Date	Revision	Pages	Changes
June 2007	0.1		Initial revision (Preliminary)
January 2009	1.0		Complete rework.
March 2010	1.1		New format, implementation of pictograms.
June 2012	2.0		Moisture Sensitivity Level adapted.
November 2013	3		Document partially restructured and clarifications added.
May 2014	4		ESD bag recommendation changed, reconditioning procedure added
March 2018	5		ESD bag recommendation changed, Pictograms updated, conformal coating added
May 2020	6		Conformal coating recommendation changed; coating information added
June 2021	7		Soldering information added; new suitable conformal coatings added
February 2023	8	All Multiple Multiple	Reformatting and reformulation Updated compatible & Incompatible conformal coatings. Updated recommendation from SHT3x to SHT4x
June 2023	8.1	4	Added Disclaimer for Vapor Phase Soldering in section 2
October 2023	8.2	Multiple 8 8 10	Corrected typos Image format changed Changed “absorbs” to “desorbs” Added section about protective cover visual anomalies
February 2024	8.3	10	Added disclaimer about conformal coating residues
June 2025	9	10 Multiple Multiple Multiple Multiple	Updated protective cover indications Reformatting and reformulation Reorganized material compatibility tables Updated material recommendations Updated contamination guidelines

Important Notices

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 (including death). 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 purchases or uses 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 is allegedly negligent with respect to the design or the manufacture of the product.

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. See application note "ESD, Latchup and EMC" for more information.

Warranty

SENSIRION solely warrants to the original purchaser of this product for a period of 12 months (one year) from the date of delivery that this product is 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 as sole and exclusive remedy, in SENSIRION's discretion, repair this product or send a replacement product, free of charge to the Buyer, provided that:

- notice in writing describing the defects shall be given to SENSIRION within fourteen (14) days after their appearance;
- such defects shall be found, to SENSIRION's reasonable satisfaction, to have arisen from SENSIRION's faulty 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.

The Buyer shall at its own expense arrange for any dismantling and reassembly that is necessary to repair or replace the defective product. This warranty does not apply to any product which has not been installed or used within the specifications recommended by SENSIRION. EXCEPT FOR THE WARRANTIES EXPRESSLY SET FORTH HEREIN, SENSIRION MAKES NO WARRANTIES, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THE PRODUCT. ANY AND ALL WARRANTIES, INCLUDING WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY EXCLUDED AND DECLINED.

SENSIRION is only liable for defects of this product arising under the conditions of operation provided for in the data sheet and proper use of the goods. SENSIRION explicitly disclaims all warranties, express or implied, if the goods are operated or stored not in accordance with the technical specifications.

SENSIRION does not assume any liability arising out of any application or use of any product or circuit and specifically disclaims any and all liability, including without limitation indirect, consequential, and incidental damages, and loss of profit. No obligation or liability shall arise or grow out of SENSIRION's rendering of technical advice, consulting, or implementation instructions or guidelines. All operating parameters, including without limitation recommended parameters, must be validated for each Buyer's applications by Buyer's technical experts. Recommended parameters can and do vary in different applications.

SENSIRION reserves the right, without further notice, (i) to change the product specifications and/or the information in this document and (ii) to improve reliability, functions and design of this product.

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