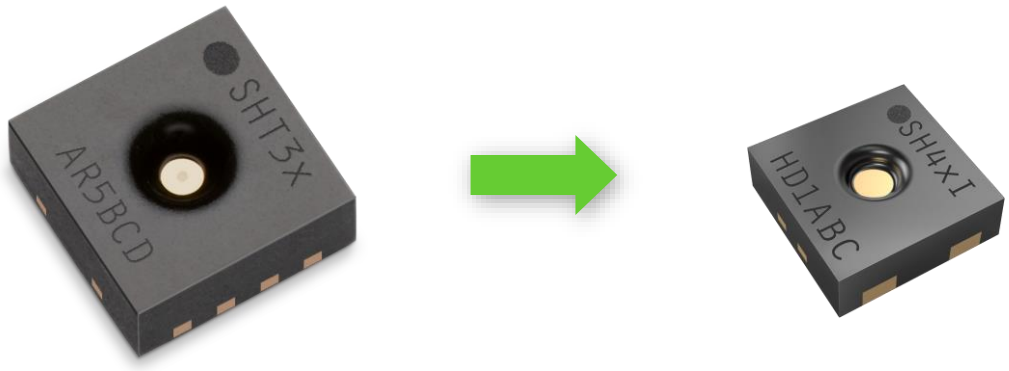
SENSIRION

SHT3x – SHT4x Transition Guide for Analog Sensors

Boarding the new flagship RH/T sensor generation

SHT3x SHT4x



- Improved accuracy and robustness
- Higher driving strength
- Powerful internal heater for self-decontamination and creep prevention
- Superior versatility and technology from two decades of sensor development

Abstract

Introduced as a highly versatile humidity (RH) and temperature (T) sensor platform, the SHT3x family already enables outstanding sensing performance for several years. Sensirion now proudly features its all-new flagship sensors from the SHT4x family, which profit from about two decades of RH/T sensor development. Dedicated to best-in-class performance, smallest footprint, and attractive pricing, our new SHT4x sensors are the products of choice for many SHT3x applications. In particular, the SHT4x outperforms the SHT3x in every aspect and offers versatile add-ons, such as a powerful heater for self-decontamination, conformal coating protection, or filter membranes. Moreover, the latest analog output circuitry enables reduced the PSRR (Power Supply Rejection Ratio) and further increase of the driving strength of the load.

Important changes

Parameter	SHT30	SHT40
Dimensions (mm^3)	2.5 × 2.5 × 0.9	1.5 × 1.5 × 0.5
Pin assignment	8 pins	4 pins
Interface	5 Analog output characteristics	5 Analog output characteristics
Supply voltage (V)	2.4 – 5.5	4.5 – 5.5
Av. current (µA)	220	520
Typ. RH accuracy (%RH)	±3.0	±2.5
Typ. T accuracy (°C)	±0.3	±0.3
Response time τ63% (s)	8	4
Additional features	Heater for plausibility checks only.	Powerful heater with $\Delta T \geq 60°C$, Full condensation robustness

Table of Contents

1 General

This document first highlights the new features and differences from the previous generation. It then aims to provide a high-level guideline to replace SHT3x with sensors from the SHT4x family and outlines important differences to be considered in design-in processes.

2 Performance Comparison

2.1 Relative Humidity and Temperature

Parameter	Conditions	SHT3x	SHT4x	Units
Relative humidity				
RH accuracy[1]	Typ.	**±3**	**±2.5**	%RH
Repeatability[2]	-	**0.1**	**0.5**	%RH
Resolution[3]	-	0.01	0.01	%RH
Hysteresis	-	±0.8	±0.8	%RH
Specified range[4]	extended[5]	0 to 100	0 to 100	%RH
Response time[6]	τ 63%	**8**	**4**	s
Long-term drift[7]	Typ.	<0.25	<0.2	%RH/y
Sensitivity	V_{DD} = 5.0 V	40	40	mV/%RH
Condensation behavior	Droplet formation	**Slight signal drop**	**No signal drop**	-
Temperature				
T Accuracy[1]	Typ.	**±0.3**	**±0.3**	°C
Repeatability[2]	-	**0.06**	**0.1**	°C
Resolution[3]	-	0.01	0.01	°C
Specified range[4]	-	−40 to +125	−40 to +125	°C
Response time[8]	τ 63%	**>2**	**2**	s
Long-term drift[9]	Typ.	< 0.03	< 0.03	°C/y
Sensitivity	V_{DD} = 5.0 V	22.9	23	mV/°C

Table 1. Humidity and temperature specifications of the SHT3x and SHT4x, where bold values highlight important differences. For further details, kindly refer to the SHT3x and SHT4x datasheets.

[1] For definition of typ. accuracy, please refer to the document “Sensirion Humidity Sensor Specification Statement”.

[2] The stated repeatability is 3 times the standard deviation (3σ) of multiple consecutive measurement values at constant conditions and is a measure for the noise on the physical sensor output.

[3] Resolution of A/D converter.

[4] Specified range refers to the range for which the humidity or temperature sensor specification is guaranteed.

[5] For details about recommended humidity and temperature operating range, please refer to the SHT4x Datasheet.

[6] Time for achieving 63% of a humidity step function, valid at 25°C and 1 m/s airflow. Humidity response time in the application depends on the design-in of the sensor.

[7] Typical value for operation in normal RH/T operating range. Max. value is < 0.5 %RH/y. Value may be higher in environments with vaporized solvents, out-gassing tapes, adhesives, packaging materials, etc. For more details, please refer to Handling Instructions.

[8] Temperature response time depends on heat conductivity of sensor substrate and design-in of sensor in application.

[9] Max. value is < 0.04°C/y.

2.2 Electrical Characteristics

Parameter	Symbol	Conditions	SHT3x			SHT4x			Units
			Min	Typ.	Max	Min	Typ.	Max	
Supply voltage	V_{DD}		**2.4**	**3.3**	**5.5**	**4.5**	**5**	**5.5**	V
Power-up/down level	V_{POR}	Static power supply	**1.8**	**2.3**	**2.4**	**0.75**	**0.9**	**1.0**	V
Slew rate change of the supply voltage	$V_{DD,slew}$		-	-	20	-	-	20	V/ms
Supply current	I_{DD}	Measurement	**-**	**220**	**300**	**-**	**520**	**850**	µA
Resistive load to VSS	R_L		**50**	**>1000**	**-**	**50**	**-**	**-**	kΩ
Capacitive load	C_L		**1**	**3.9**	**5**	**-**	**-**	**100**	nF
Application circuit design	-	-	Largely advantageous for SHT4x, see **Section 6**						-

Table 2. Key electrical specifications of the SHT3x and SHT4x, where bold values highlight important differences. For further details, kindly refer to the SHT3x and SHT4x datasheets.

2.3 Timing Specifications

Parameter	Symbol	Conditions	SHT3x			SHT4x			Units
			Min	Typ.	Max	Min	Typ.	Max	
Power-up time	t_{PU}	After hard reset, $V_{DD} \geq V_{POR}$	-	**-**	17	-	**7**	15	ms
Analog out settling time		For a step of V_{DD} /2	-	0.3			**200**		ms
Measurement interval	$t_{Measint}$	Heater disabled					**0.5**		s
Heater-on duration[10]	t_{Heat}		-	-	-	**0**		**2**	s

Table 3. Key timing specifications of the SHT3x and SHT4x, where bold values highlight important differences. For further details, kindly refer to the SHT3x and SHT4x datasheets.

3 Flagship SHT4x Feature: Built-In Heater

The SHT4x analog sensor incorporates an optional powerful on-chip heater on request, which can be used for self-decontamination, *e.g.*, in environments with solvents present, and periodical creep compensation in prolonged application in highest humidity. It provides an over-temperature up to about 60 °C and different heater powers (up to 200 mW) and durations (up to 2 s) can be selected. There is no dedicated command to turn off the heater since it has an internal timer after which it is switched off automatically. However, it is important to note that in case the active heater option is chosen by the user, the sensor will be continuously running periodic heating pulses in specific measurement intervals defined at factory level.

[10] Possible heater-on durations: 0.1, 0.5, 1, 2 s

4 Package Differences

The SHT4x comes in a new open-cavity dual flat no lead (DFN) package design in order to enable additional features, such as conformal coating, protection cover, and filter membrane compatibility. In comparison to the SHT3x, the package is considerably smaller, **enabling power efficient**, accurate, and robust RH/T sensing with fast reaction times. Instead of featuring eight pins, the bottom side of the SHT4x DFN package exposes four metallic contacts, which are Ni/Pd/Au coated.

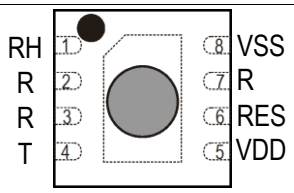
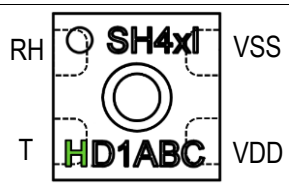
Parameter	Units	SHT3x	SHT4x	Comment
Size	mm	2.5 x 2.5 x 0.9	1.5 x 1.5 x 0.5	For details, see **Figure 1**, **Figure 2**.
Sensor opening	-	Top	Top	
Protection compatibility	-	Compatible with conformal coating, Compatible with filter membranes	Compatible with conformal coating, Compatible with filter membranes	
Pin Layout	-	2 x 4 pins	2 x 2 pins	
Necessity for fine-print PCB	-	no	no	
Pin Assignment	-			Drawings not to scale VDD: Supply voltage SCL: Serial clock SDA: Serial data bidirectional VSS: Ground R: no electrical function
Pin Size	mm	0.25 x 0.35	0.3 x 0.3	
Pin Pitch	mm	0.5	0.8	
Pin Material	-	Ni/Pd/Au coated Cu	Ni/Pd/Au coated Cu	
Housing Material	-	Epoxy housing	Epoxy housing	

Table 4. Key package differences between the SHT3x and SHT4x. For further details, kindly refer to the SHT3x and SHT4x datasheets

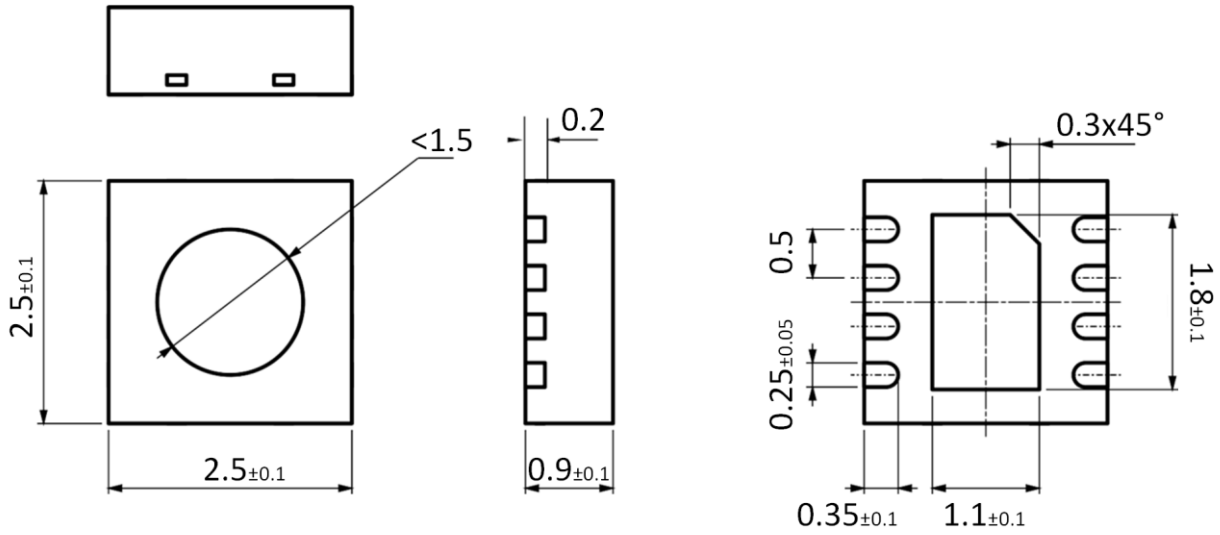


Figure 1. Dimensional drawing of the SHT3x including (units mm).

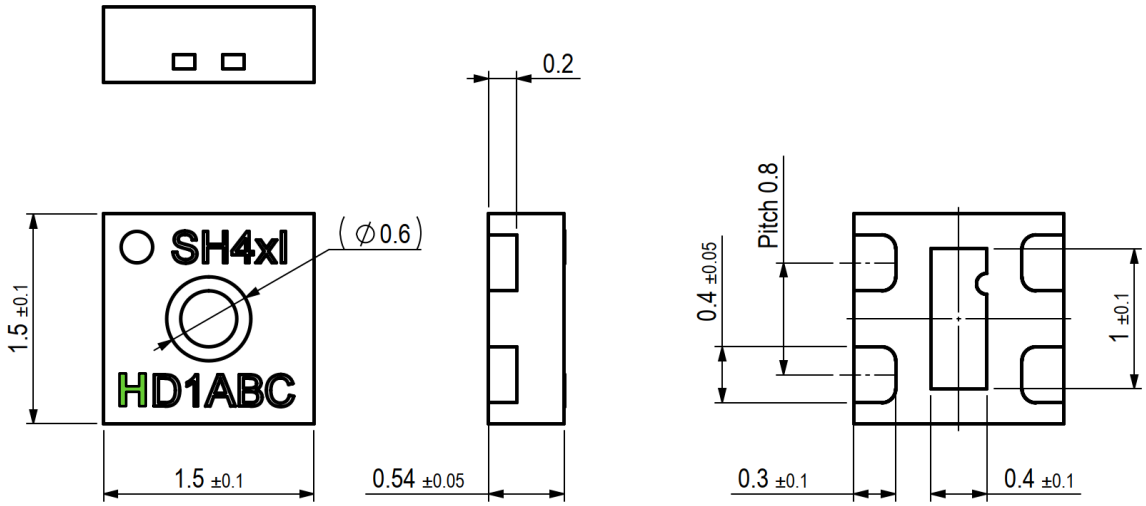


Figure 2. Dimensional drawing of SHT4x including package tolerances (units mm).

5 Communication and Signal Output

The start-up of the sensor and the conversion of the signal output have not undergone major changes, apart from the power-up/down levels reported in **Table 2**. In addition, all the voltage output characteristics have been maintained, only the names have been changed following the scheme reported in **Table 5**.

SHT3x	SHT4x
SHT3x-**ARP**	SHT4xI-**H**D1B
SHT3x-**T1RP**	SHT4xI-**I**D1B
SHT3x-**RARP**	SHT4xI-**J**D1B
SHT3x-**R1RP**	SHT4xI-**K**D1B
SHT3x-**T2RP**	SHT4xI-**L**D1B

Table 5. New nomenclature of the SHT4x version and corresponding SHT3x version.

6 New Features and Design-in Advantages

The new SHT4x generation shows two main improvements in the analog output circuitry with respect to the previous SHT3x version. First, the new design introduces several enhancements (reference filtering, output buffer optimized bandwidth…) to improve the Power Supply Rejection Ratio (PSRR), which yields less noise on the output signals. Second, the new design of the output buffers strongly increases the driving capability of resistive and capacitive loads (down to 1 kΩ and up to 100 nF respectively). Moreover, it is worth comparing the SHT4x sensor to the existing solutions available in the analog market. **Table 6** reports some examples of Sensirion solutions and other SMD sensors.

	Haechitech MXH1100	**TE-Connectivity** HTU31V	**Sensirion** SHT3x	**Sensirion** SHT4x
Capacitive load up to	400 pF	5 nF	5 nF	100 nF

Table 6. Capacitive load comparison considering chip size analog sensors

In terms of design-in advantages, the new SHT4x improved PSRR and the higher output current allow major overall cost savings. In fact, any active filtering circuitry at the sensor's output is no longer needed to improve PSRR or to drive long cables.

The following figures highlight the improvements just mentioned compared to the previous sensor generation. The first schematic (**Figure 3**) shows a standard application of the SHT3x in which loads are directly connected to the output pins. This configuration has two main limitations: the output signals are subject to significant noise and it cannot drive significant loads.

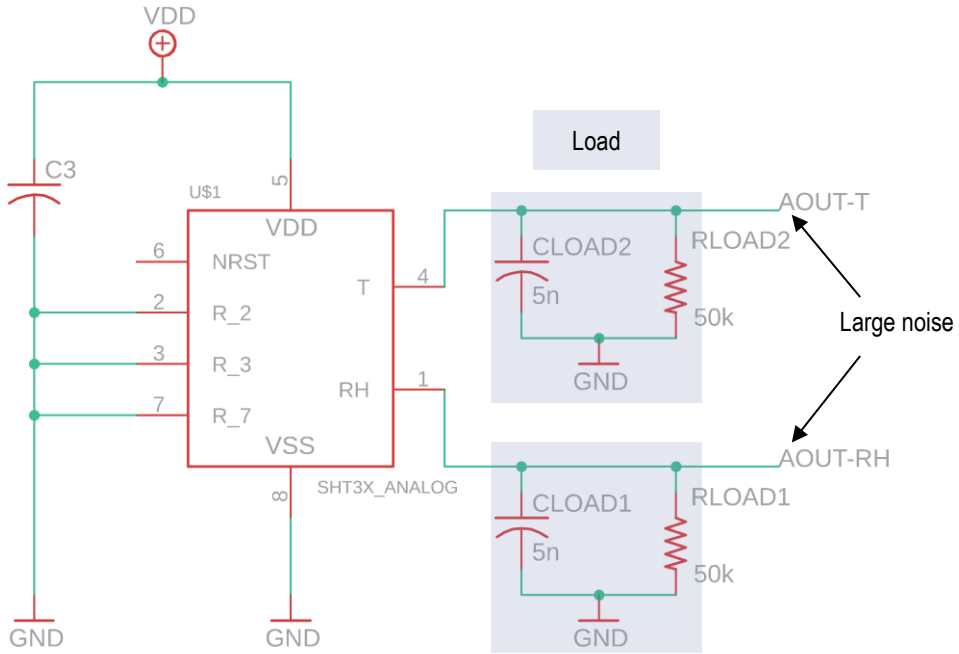


Figure 3. Standard schematic for the SHT3x. Load is directly connected to the sensor, but there is large noise at the output.

To improve these limitations, some additional components may be introduced between the SHT3x sensor and the load, as shown in **Figure 4**. In this example, the first external stage is a passive RC filter to reduce the noise while the second external stage is an OpAmp (Operational Amplifier) to increase the driving capability. If this solution improves the overall performance, it also significantly increases the total production costs.

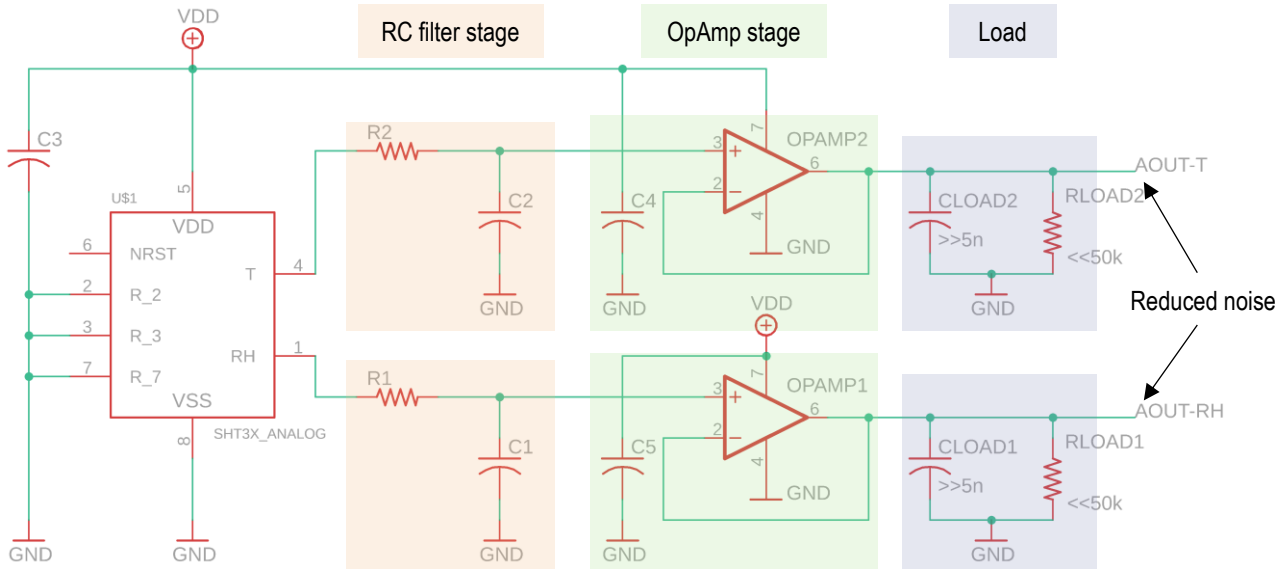


Figure 4. Possible improved schematic for the SHT3x. This solution allows greater drive capability and reduces output noise. However, it considerably increases the overall costs of the final product.

On the other hand, the implementation of the new SHT4xI sensor brings evident design-in advantages and improves performances as well. Thanks to the new chip design, significant loads can now be connected directly to the output pins while no additional noise-filtering stage is needed. This dramatically simplifies the final product, as reported in **Figure 5**, and results in significant cost saving.

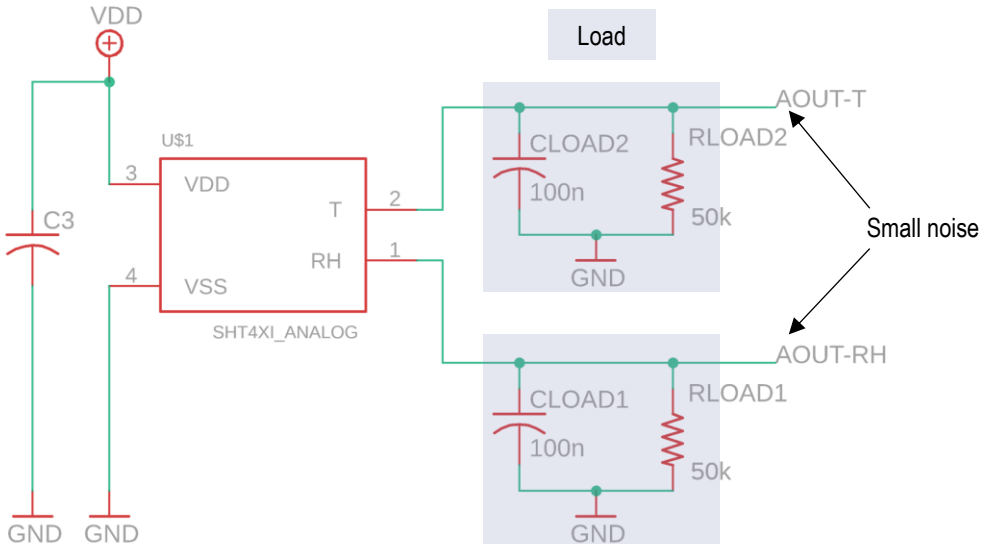


Figure 5. Standard schematic for the new SHT4xI analog sensor. Significant loads can be directly connected to the sensor and the output signals have negligible noise.

Please note that potential self-heating may affect the sensors performance. The self heating depends on the sensors load, the measurement intensity and the thermal mass and conductivity of the surrounding. To avoid any problems with self heating follow the design-in guidelines provided by Sensiron.

7 Quality and Material Contents

Qualification of the SHT3x and SHT4x is performed based on the JEDEC JESD47 qualification test method. W devices are fully RoHS and REACH compliant, the SHT4x is also WEEE compliant.

8 Further Information

This transition guide aims at providing an overview of the key differences between the SHT3x and the SHT4x, yet it might not be fully inclusive. For further reading on the SHT4x specifications, communication, operation, and application, please consult the dedicated SHT3x and SHT4x documents provided on the Sensirion webpage www.sensirion.com. In case you are in need of specific details, or would like to request assistance in transitioning from the SHT3x to the SHT4x or any other Sensirion product, please consult us directly at www.sensirion.com/en/about-us/contact/.

9 Revision History

Date	Version	Page(s)	Changes
April 2022	1	all	Initial version
November 2023	1.1	all	Updated SHT40 information
February 2024	1.2	4,8	Adapted recommended resistive load for SHT4x Added remark about self heating

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. 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.

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.

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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:

- 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 design, material, or workmanship;
- the defective product shall be returned to SENSIRION's factory at the Buyer's expense; and
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