

## Datasheet SCD40 CO<sub>2</sub>, RH and T Sensor

- Photoacoustic CO<sub>2</sub> sensor technology
- Integrated temperature and humidity sensor
- Best performance-to-price ratio
- Smallest form factor: 10.1 mm x 10.1 mm x 6.5 mm
- Measurement range: 0 ppm – 40'000 ppm
- Accuracy:  $\pm(50 \text{ ppm} + 5\%)$
- Fully calibrated and linearized output
- Digital interface I<sup>2</sup>C
- SMD for cost- and space-saving integration



### Product Summary

The SCD40 is Sensirion's next generation miniature CO<sub>2</sub>, RH and T sensor. This sensor builds on the photoacoustic sensing principle and Sensirion's patented PAsens® and CMOSens® technology to offer high accuracy at an unmatched price and smallest form factor. SMD assembly allows cost- and space-effective integration of the sensor combined with maximal freedom of design. Finally, ambient humidity and temperature can be measured by Sensirion's algorithm expertise through modelling and compensating of external heat sources without the need for any additional components.

CO<sub>2</sub> is a key indicator for indoor air quality as high levels compromise human health and productivity. Thus, the SCD40 enables smart ventilating systems in the commercial and the residential sector to regulate ventilation in the most energy-efficient and human-friendly way. Furthermore, CO<sub>2</sub> sensors play an essential role for indoor air quality monitoring and are therefore integrated in IAQ monitors, air purifiers, smart thermostats and similar devices.

Note that the white dust and water protection membrane on top of the sensor cap must not be removed at any time.

### Block Diagram

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# 1 Sensor Performance<sup>1</sup>

## 1.1 CO<sub>2</sub> Sensing Performance

Parameter	Conditions	Value
CO <sub>2</sub> measurement range	-	0 – 40'000 ppm
Accuracy <sup>2</sup>	0 ppm – 5'000 ppm	± (50 ppm + 5% of reading)
Repeatability <sup>3</sup>	0 ppm – 5'000 ppm	± 10 ppm
Response time <sup>4</sup>	T <sub>63%</sub>	60 s
Accuracy drift per year <sup>5</sup>	400 ppm – 5'000 ppm ASC field-calibration algorithm activated or FRC field-calibration function performed.	Typical: <sup>6</sup> ± (5 ppm + 0.5 % of reading)

**Table 1:** SCD40 CO<sub>2</sub> sensor specifications

## 1.2 Humidity Sensing Performance<sup>7</sup>

Parameter	Conditions	Value
Humidity measurement range	-	0 %RH – 95 %RH
Accuracy <sup>8</sup>	25°C, 0 – 95 %RH	± 5 %RH
Repeatability <sup>3</sup>	-	± 0.3 %RH
Response time <sup>4</sup>	T <sub>63%</sub>	> 90 s
Accuracy drift	-	< 0.25 %RH / year

**Table 2:** SCD40 humidity sensor specifications

## 1.3 Temperature Sensing Performance<sup>7</sup>

Parameter	Conditions	Value
Temperature measurement range <sup>9</sup>	-	- 20°C – 60°C
Accuracy <sup>7 10</sup>	0 – 50°C	± (0.8°C + 0.023 ×  (T [°C] – 25°C) )
Repeatability <sup>3</sup>	-	± 0.1°C
Response time <sup>4</sup>	T <sub>63%</sub>	> 90 s
Accuracy drift	-	< 0.03 °C / year

**Table 3:** SCD40 temperature sensor specifications

<sup>1</sup> Default conditions of T = 25°C, humidity = 50 %RH, p = 1013 mbar.

<sup>2</sup> Deviation to a high-precision reference. Accuracy is fulfilled by > 90% of the sensors after calibration. Rough handling, shipping and soldering reduces the accuracy of the sensor. Full accuracy is restored with FRC or ASC recalibration features. Accuracy is based on tests with gas mixtures having a tolerance of ± 1.5%.

<sup>3</sup> RMS error of consecutive measurements at constant conditions. Repeatability is fulfilled by > 90% of the sensors.

<sup>4</sup> Time for achieving 63% of a respective step function. Response time depends on the operating mode, design-in and environment of the sensor in the final application. The specified response time represents ideal design-in situation and high performance mode operation.

<sup>5</sup> For proper function of ASC field-calibration algorithm SCD40 has to be exposed to air with CO<sub>2</sub> concentration 400 ppm regularly.

<sup>6</sup> Typical value if operated in normal RH/T operating range, see section 2.1. Maximum value is ± (5 ppm + 2 % of reading). Higher drift values might occur if the sensor is not handled according to its handling instructions.

<sup>7</sup> Design-in of the SCD40 in final application and the environment impacts the accuracy of the RH/T sensor. Heat sources have to be considered for optimal performance. Please use integrated on-board RH/T compensation algorithm to account for the actual design-in.

<sup>8</sup> Deviation to a high-precision reference. Accuracy is fulfilled by > 90% of the sensors after calibration.

<sup>9</sup> RH/T sensor component is capable of measuring up to T = 120°C. However, measuring at T > 70°C might result in permanent damage of the sensor module.

<sup>10</sup> Best temperature accuracy is realized when SCD40 is operated in a low power mode.

## 2 Electrical Specifications

Parameter	Conditions	Value
Average current <sup>11</sup>	High performance mode, VDD=3.3 V / 5 V Low power mode, VDD=3.3 V / 5 V Ultra low power mode, VDD=3.3 V / 5V	< 60 mA / < 40 mA < 12 mA / < 8 mA < 1.5 mA / < 1 mA
Max. current <sup>12</sup>	During measurement, VDD=3.3 V / 5 V	170 mA / 115 mA
DC supply voltage (V <sub>ddmin</sub> - V <sub>ddmax</sub> ) <sup>13</sup>	Min. and max. criteria to operate SCD40	2.4 – 5.5 V
Interface	-	I <sup>2</sup> C
Input high level voltage (V <sub>IH</sub> )	Min. and max. criteria to operate SCD40	0.7 x VDD – 1 x VDD
Input low level voltage (V <sub>IL</sub> )	Min. and max. criteria to operate SCD40	-0.5 x VDD – 0.3 x VDD
Output low level voltage (V <sub>OL</sub> )	3 mA sink current	0.66 V

**Table 4** SCD40 electrical specifications

### 2.1 Operation Conditions, Lifetime and Maximum Ratings

Parameter	Conditions	Value
Temperature operating conditions		-20 – 60°C
Humidity operating conditions <sup>14</sup>	Non-condensing.	0 – 95 %RH
DC supply voltage	Exceeding specified range will result in damage of the sensor.	- 0.3 V – 6.0V
Max voltage on pins SDA, SCL, GND	Exceeding specified range will result in damage of the sensor.	-0.3 to VDD+0.3
Input current on pins SDA, SCL, GND	Exceeding specified range will result in damage of the sensor.	+/- 100 mA
Storage temperature conditions	Exceeding specified range will result in damage of the sensor.	- 40°C – 70°C
ESD HBM		2 kV
ESD CDM		500 V
Maintenance Interval	Maintenance free when ASC field-calibration algorithm <sup>15</sup> is used.	None
Sensor lifetime	-	> 10 years

**Table 5:** SCD40 operation conditions, lifetime and maximum ratings

<sup>11</sup> Average current including idle state and processing.

<sup>12</sup> Power supply should be designed with respect to maximum current.

<sup>13</sup> FRC must be applied to engineering samples that are not operated at 3.3 V to realize full accuracy.

<sup>14</sup> Operating the SCD40 at a relative humidity lower than 10 % can result in compromised accuracy

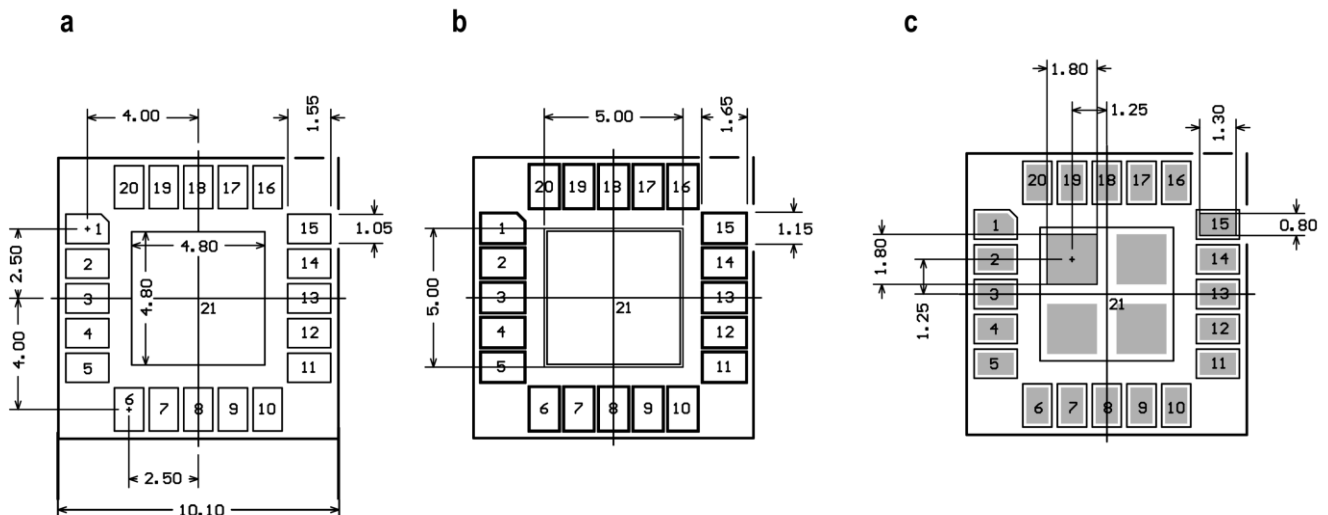
<sup>15</sup> For proper function of ASC field-calibration algorithm SCD40 has to be exposed to air with 400 ppm regularly.

### 3 Interface Specifications

The SCD40 comes in an LGA package, see Table 6.

Name	Comments	
VDD	Supply voltage	
VDDH	Supply voltage, IR source	
GND	Ground contact	
SDA	Serial data, bidirectional	
SCL	Serial clock	
DNC	Do not connect, pads must be soldered to a floating pad on the customer PCB	

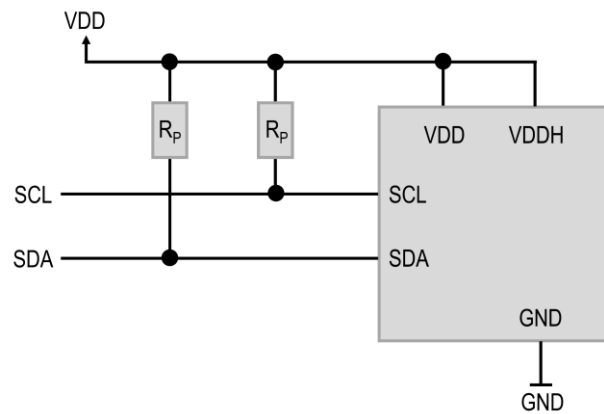
**Table 6** Pin assignment (top view).



**Figure 2:** SCD40 Footprint (top view): landing pads (a), soldermask (b) and solderpaste (c).

SCL is used to synchronize the communication between the microcontroller and the sensor. The SDA pin is used to transfer data to and from the sensor. For safe communication, the timing specifications defined in the I<sup>2</sup>C manual<sup>16</sup> must be met. Both SCL and SDA lines should be connected to external pull-up resistors. To avoid signal contention, the microcontroller must only drive SDA and SCL low. The external pull-up resistors (e.g.  $R_p = 10\text{ k}\Omega$ ) are required to pull the signal high. For dimensioning resistor sizes please take bus capacity and communication frequency into account (see for example Section 7.1 of NXPs I<sup>2</sup>C Manual for more details<sup>16</sup>). It should be noted that pull-up resistors may be included in I/O circuits of microcontrollers.

<sup>16</sup> [http://www.nxp.com/documents/user\\_manual/UM10204.pdf](http://www.nxp.com/documents/user_manual/UM10204.pdf)



**Figure 3:** Typical application circuit (for better clarity in the image, the positioning of the pins does not reflect the positions on the real sensor). VDD and VDDH must be connected to each other close to the sensor on the customer PCB.

## 1 Important Notices

### a. 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.**

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### b. 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.

### c. 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: 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 the warranty period for any repaired or replaced product shall be limited to the unexpired portion of the original period.

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