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Data sheet and manual

# SenseAir® S8

## Residential

Miniature infrared $CO_2$ sensor module


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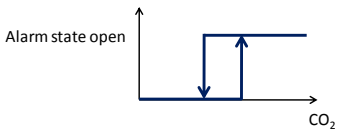
| Item | *SenseAir® S8 Residential Article no. 004-0-0013* |
|---|---|
| **Target gas** | $CO_2$ |
| **Operating Principle** | Non-dispersive infrared (NDIR) |
| **Measurement range** | 400 to 2000 ppm (Note 1). Up to 10000ppm extended range |
| **Measurement interval** | 2 seconds |
| **Accuracy** | ±70 ppm ±3% of reading (Notes 3 and 4) |
| **Pressure dependence** | + 1.6 % reading per kPa deviation from normal pressure |
| **Response time** | 2 minutes by 90% |
| **Operating temperature** | 0 to 50°C |
| **Operating humidity** | 0 to 85% RH non condensed |
| **Storage temperature** | -40 to 70°C |
| **Dimensions (mm)** | 33.5 x 20 x 8.5mm (max dimensions) |
| **Weight** | < 8 grams |
| **Power supply** | 4.5 to 5.25V unprotected against surges and reverse connection |
| **Power consumption** | 300mA peak, 30mA average |
| **Life expectancy** | 15+ years |
| **Compliance with** | Emission: EN 61000-6-3:2007, EN 61000-6-4:2007<br>Immunity: EN 61000-6-1:2007<br>RoHS directive 2011/65/EU |
| **Serial communication** | UART, Modbus protocol (Note 5). Direction control pin for direct connection to RS485 receiver integrated circuit. |
| **Alarm output, Open Collector** |  1000/800ppm Normal state is conducting max 100 mA. Transistor open at CO2 High, OR Power Low, OR at Sensor Failure |
| **PWM output, 1 kHz** | 0 to 100% duty cycle for 0 to 2000ppm<br>3.3V push-pull CMOS output, unprotected |
| **Maintenance** | Maintenance-free for normal indoor applications with SenseAir® |

*Table 1. Key technical specification for the SenseAir® S8 Residential*

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Note 1: Sensor is designed to measure in the range 400 to 2000 ppm with specified in the table accuracy. Nevertheless exposure to concentrations below 400 ppm may result in incorrect operation of ABC algorithm and shall be avoided for model with ABC on.

Note 2: Sensor provides readings via UART in the extended range but the accuracy is degraded compared to specification in the table one.

Note 3: In normal IAQ applications. Accuracy is defined after minimum 3 weeks of continuous operation with ABC on. However, some industrial applications do require maintenance. Please, contact SenseAir for further information!

Note 4: Accuracy is specified over operating temperature range. Specification is referenced to certified calibration mixtures. Uncertainty of calibration gas mixtures (+-2% currently) is to be added to the specified accuracy for absolute measurements.

Note 5: See specification *{* Modbus on SenseAir_R_S8 rev_P11_1_00.*doc preliminary specification}*

## Absolute maximum ratings

Stress greater than those listed in Table 2 may cause permanent damage to the device. These ratings are stress ratings only. Operation of the device at any condition outside those indicated in the operational section of these specifications is not implied. Exposure to absolute maximum rating for extended periods may affect device reliability.

| Parameter | Minimum | Maximum | Units | Notes |
|---|---|---|---|---|
| Ambient temperature under bias | - 40 | 85 | C | |
| Voltage on G+ pin with respect to G0 pin | - 0.3 | 5.5 | V | 1, 2 |
| Maximum output current from active output pin | - 25 | + 25 | mA | 1 |
| Maximum current on input | - 5 | + 5 | uA | 1 |
| Maximum voltage on UART lines, PWM and bCAL_in | - 0.3 | DVCC_out + | V | 1 |
| Maximum voltage on Alarm_OC | - 0.3 | 12 | V | 1,3 |

*Table 2. Absolute maximum ratings specification for the SenseAir® S8 Residential*

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Note 1: Specified parameter relies on specification of subcontractor and is not tested by SenseAir
Note 2: Refer chapter “Terminal Description” for rated voltage information
Note 3: Alarm_OC pin is internally pulled up to G+. External pull up to higher voltage will provide resistive divider powering sensor via high resistance.

## Sample gas diffusion area

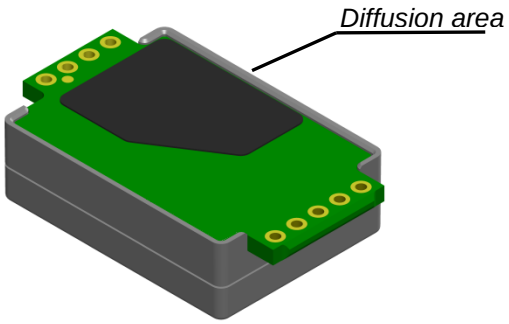


*Figure 1. Diffusion area*

## Pin assignment

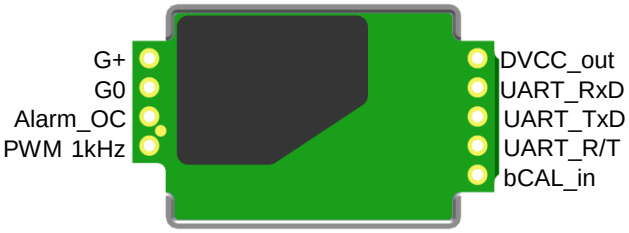


*Figure 2. Diffusion Pin assignment*

## Terminals description

The table below specifies terminals and I/O options dedicated in *SenseAir® S8 Residential* model.

| Pin Function | Pin description / Parameter description | Electrical specification |
|---|---|---|
| **Power pins** | | |
| G0 | Power supply minus terminal<br>Sensor's reference (ground) terminal | |
| G+ referred to G0 | Power supply plus terminal<br><br>Operating voltage range | Unprotected against reverse connection!<br>4.5V to 5.25V |
| DVCC_out | Output<br>from sensor's voltage regulator<br>Output may be used to logical level converter if master processor runs at 5V supply voltage.<br>Series resistance<br>Nominal voltage<br>Allowed source current<br>Voltage precision (Note 1) | Induced noise or excessive current drawn may affect sensor performance. External series resistor is strongly recommended if this pin is used<br>No internal protection!<br>3.3 VDC<br>6 mA max<br>± 0.75% is typical, ± 3% is max |
| **Communication pins** | | |
| UART_TxD | UART data transmission line<br>Configured as digital output<br><br><br>Absolute max voltage range (Note 1)<br>Internal pull up to DVCC_out resistor<br>Output low level (Note 1)<br>Output high level (Note 1) | No internal protection<br>Pulled up to DVCC_out at processor reset<br>(power up and power down)<br>G0 - 0.3V to DVCC_out + 0.5V<br>120k<br>0.75 VDC max at 10mA sink<br>2.4 VDC at 2mA source |
| UART_RxD | UART data receive line<br>Configured as digital input<br><br><br>Absolute max voltage range(Note 1)<br>Internal pull up to DVCC_out resistor<br>Input low level (Note 1)<br>Input high level (Note 1) | No internal protection<br>Pulled up to DVCC_out at processor reset<br>(power up and power down)<br>G0 - 0.3V to DVCC_out + 0.5V<br>120k<br>- 0.3V to 0.75V<br>2.3V to DVCC_out + 0.3V |
| UART_R/T | Direction control line for half duplex RS485 transceiver like MAX485.<br>Configured as digital output<br>Absolute max voltage range(Note 1)<br>Internal pull down to G0 resistor<br>Output low level (Note 1)<br>Output high level (Note 1) | No internal protection,<br>Pulled down at processor reset<br>(power up and power down)<br>G0 - 0.3V to DVCC_out + 0.5V<br>120k<br>0.75 VDC max at 10mA sink<br>2.4 VDC at 2mA source |

*Table 3. I/O notations, description and electrical specification. (continued on next page)*

| Pin Function | Pin description / Parameter description | Electrical specification |
|---|---|---|
| **Input / output** | | |
| bCAL_in/ CAL | Digital input forcing background calibration. Configured as digital input<br>(when closed for minimum 4, max 8 seconds) bCAL (background calibration) assuming 400 ppm CO2 sensor exposure<br><br>Zero calibration<br>(when closed for minimum 16 seconds) CAL (zero calibration) assuming 0 ppm CO2 sensor exposure | No internal protection,<br>Pulled up to DVCC_out at processor reset<br>(power up and power down) |
| | Absolute max voltage range(Note 1) | G0 - 0.3V to DVCC_out + 0.5V |
| | Internal pull up to DVCC_out resistor | 120k |
| | Input low level (Note 1) | - 0.3V to 0.75V |
| | Input high level (Note 1) | 2.3V to DVCC_out + 0.3V |
| PWM 1kHz | PWM output<br>Configured as digital output<br><br>Used for direct reading by customer's microcontroller or to provide analog output. | No internal protection,<br>Pulled down at processor reset<br>(power up and power down) |
| | Duty cycle min | 0%, output Low |
| | Duty cycle max | 100%, output High |
| | PWM resolution | 0.5us ± 4% |
| | PWM period | 1ms ± 4% |
| | Absolute max voltage range (Note 1) | G0 - 0.3V to DVCC_out + 0.5V |
| | Internal pull down do G0 resistor | 120k |
| | Output low level (Note 1) | 0.75 VDC max at 10mA sink |
| | Output high level (Note 1) | 2.4 VDC at 2mA source |
| Alarm_OC | Open Collector output for alarm indication | No internal protection,<br>Pulled up to G+ at processor reset<br>(power up and power down) |
| | Absolute max voltage range(Note 1) | G0 - 0.3V to 5.5V |
| | Internal pull up to G+ resistor | 120k |
| | Max sink current (Note 1) | 100 mA |
| | Saturation voltage (Note 1) | 2.3V to DVCC_out+0.3V |

*Table 3. I/O notations, description and electrical specification (continue, see previous page).*

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Note 1: Specified parameter relies on specification of subcontractor and is not tested by SenseAir

## Mechanical properties

Please refer to mechanical drawing for detailed specification of dimensions and tolerances.
See Handling manual for S8 (ANO102).

## Installation and soldering

See Handling manual for S8 (ANO102).

# Maintenance and ABC (Automatic Baseline Correction)

The models based on *SenseAir® S8 Residential* platform are basically maintenance free in normal environments thanks to the built-in self-correcting ***ABC* algorithm** *(Automatic Baseline Correction)*. This algorithm constantly keeps track of the sensor's lowest reading over preconfigured time interval and slowly corrects for any long-term drift detected as compared to the expected fresh air value of 400ppm (or 0.04%$_{vol}$) $CO_2$.
Discuss your application with SenseAir in order to get advice for a proper calibration strategy.

When checking the sensor accuracy, PLEASE NOTE that the sensor accuracy is defined at continuous operation (at least 3 weeks after installation with ABC turned on)!

| ABC parameter | Specification |
|---|---|
| ABC period | 8 days |

*Table 4. ABC default configurations for SenseAir® S8 Residential*

## Calibration

Rough handling and transportation might result in a reduction of sensor reading accuracy. With time, the ABC function will tune the readings back to the correct numbers. The default "tuning speed" is however limited to about 30-50 ppm/week.

For post calibration convenience, in the event that one cannot wait for the ABC algorithm to cure any calibration offset two manual calibration procedures are offered. A switch input is defined for the operator or master system to select one of the two prepared calibration codes. Optional calibrations are **bCAL** *(background calibration)*, which requires that the sensor is exposed to fresh air (400 ppm $CO_2$) and **CAL** *(zero calibration)*, which requires the sensor measuring cell to be completely evacuated from $CO_2$ e.g. by exposing it to Nitrogen or Soda Lime $CO_2$ scrubbed air. Make sure that the sensor environment is steady and calm!

| Input | Default function |
|---|---|
| bCAL_in | **(when closed for minimum 4, max 8 seconds)**<br>**bCAL** (background calibration) assuming 400 ppm $CO_2$ sensor exposure |
| CAL_in | **(when closed for minimum 16 seconds)**<br>**CAL** (zero calibration) assuming 0 ppm $CO_2$ sensor exposure |

*Table 5. Switch input default configurations for SenseAir® S8 Residential*

# Self-diagnostics

The system contains complete self-diagnostic procedures. A full system test is executed automatically every time the power is turned on. In addition, constantly during operation, the sensor probes are checked against failure by checking the valid dynamic measurement ranges. All EEPROM updates, initiated by the sensor itself, as well as by external connections, are checked by subsequent memory read back and data comparisons. These different system checks return error bytes to the system RAM. The full error codes are available from the UART communication port. *Out of Range* error is the only bit that is reset automatically after return to normal state. All other error bits have to be reset after return to normal by UART overwrite, or by power off/on.

## Error code and action plan

(Error code can be read via UART communication port)

| Bit # | Error code | Error description | Suggested action |
|---|---|---|---|
| 0 | 1 | **Fatal Error** | Try to restart sensor by power OFF/ON.<br>Contact local distributor. |
| 1 | 2 | **Reserved** | - |
| 2 | 4 | **Algorithm Error**.<br>Indicate wrong configuration. | Try to restart sensor by power OFF/ON.<br>Check detailed settings and configuration with software tools.<br>Contact local distributor. |
| 3 | 8 | **Output Error**<br>Detected errors during output signals calculation and generation. | Check connections and loads of outputs.<br>Check detailed status of outputs with software tools. |
| 4 | 16 | **Self-Diagnostic Error**.<br>May indicate the need of zero calibration or sensor replacement. | Check detailed self-diagnostic status with software tools. Contact local distributor. |
| 5 | 32 | **Out Of Range Error**<br>Accompanies most of other errors. Can also indicate overload or failures of sensors and inputs.<br><br>Resets automatically after source of error disappearance. | Try sensor in fresh air.<br>Perform $CO_2$ background calibration.<br>Check detailed status of measurements with software tools.<br>*See Note 1!* |
| 6 | 64 | **Memory Error**<br>Error during memory operations. | Check detailed settings and configuration with software tools. |
| 7 | 128 | **Reserved** | - |

*Table 6. Error codes for SenseAir® S8 Residential*

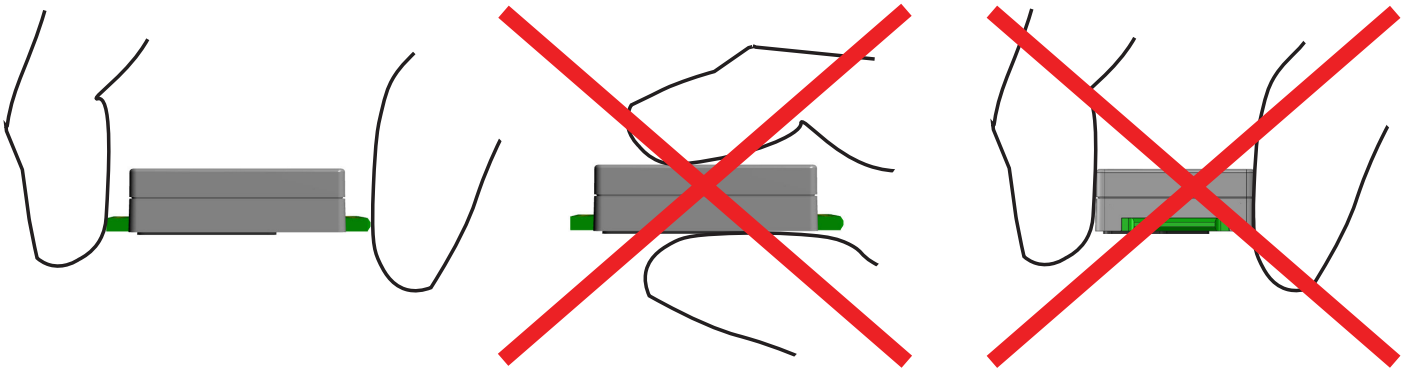
**Note 1.** *Any probe is out of range. Occurs, for instance, during over-exposure of $CO_2$ sensor, in which case the error code will automatically reset when the measurement values return to normal. Could also indicate the need of zero point calibration. If the $CO_2$ readings are normal, and still the error code remains, any other sensor probe mounted (if any) can be defect, or the connection to this probe is broken.*

**Please note**: If several errors are detected at the same time the different error code numbers will be added together into one combined error code!

# Handling Manual

# *S8*

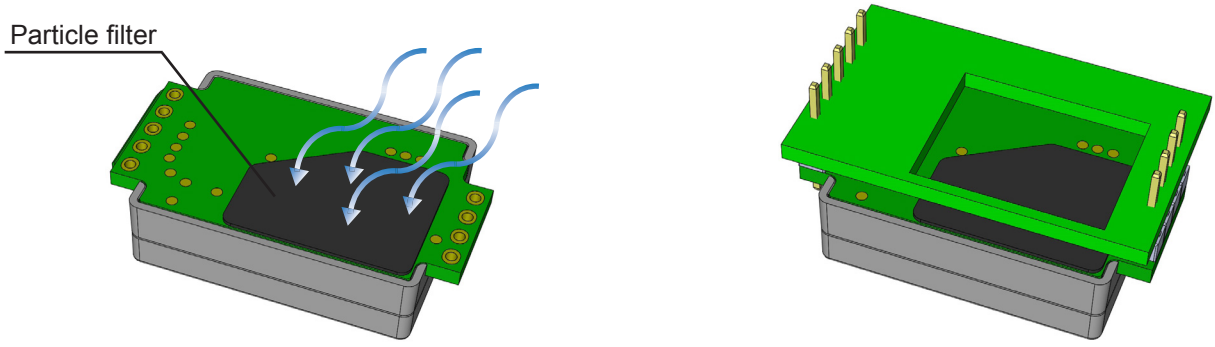
## Miniature $CO_2$ sensor module with NDIR technique



NOTE:
ESD sensitive product.
Use ESD protection equipment.

**ESD**

NOTE:
Handle sensor by holding PCB only.
Never touch sensor with bare hands! Use clean gloves to avoid dust, grease or other contaminations.
OBA shall not be subjected to any force.




NOTE:
To ensure airflow, and quick sensor response time to changes in environment: do not block particle filter!

### Installation and soldering

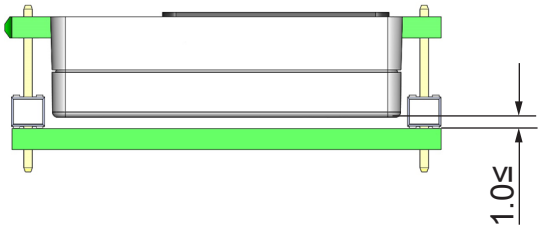
See IPC-J-STD-001 for acceptable soldering conditions in general.
**Selective soldering machine (drag soldering method):** Soldering temperature 295°C during three seconds.
**Hand soldering**: Soldering iron temperature 380°C during two seconds/pin.

### Mechanical properties

Please refer to mechanical drawing for detailed specification of dimensions and tolerances.

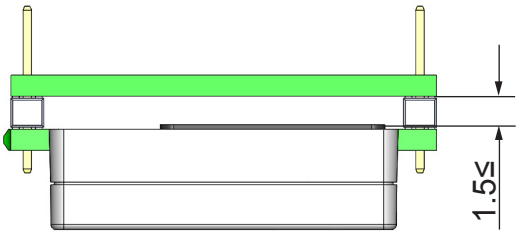
**Layout considerations:**
Use cut-outs or slits in main board to reduce mechanical stress to sensor due to board thermal expansion.

NOTE:
No gluing or moulding on OBA.



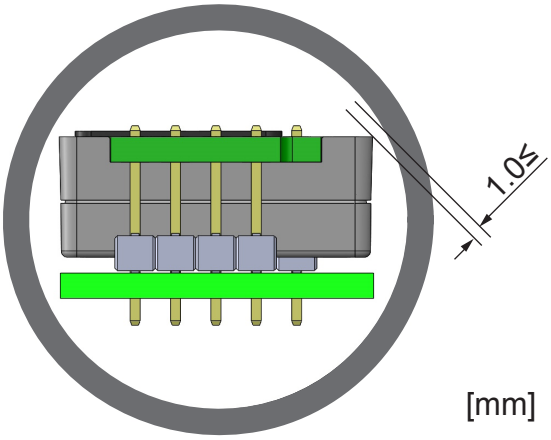

[mm]

NOTE:
1.0mm≤ minimum distance
from OBA to cover/PCB.

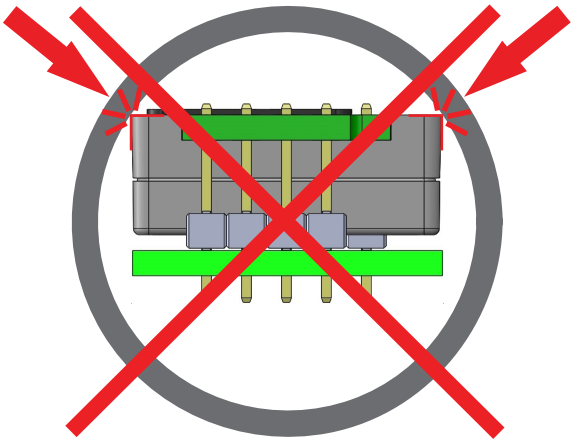



[mm]

NOTE:
1.5mm≤ minimum distance
from particle filter to cover/PCB




[mm]



NOTE:
1.0mm≤ minimum distance
from OBA to cover/PCB.

## Storage

Storage in sealed ESD bags.
Storage temperature: -40 ─ 70°C

Requirements on storage environment: In normal IAQ environments corrosive environments are excluded.

## Inspection - verification

Transport, handling and assembly may affect calibration. Accuracy is defined after minimum three weeks of continuous operation with ABC in normal IAQ applications. Different options exist and can be customized depending on the application. Please, contact SenseAir for further information!
Preferably, please inspect and perform zero calibration after any, or all, transports.