

Product Specification

Senseair S88 LP

Miniature CO₂ sensor module with NDIR technique



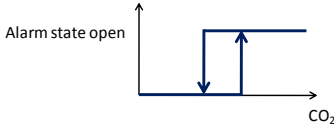
Item	Senseair S88 LP Article No. 004-1-0101
Operating principle	Non-dispersive infrared (NDIR)
Measured gas	Carbon dioxide (CO ₂)
Measurement range	400–10000ppm ^{1, 2}
Measurement interval	4s
Accuracy [CO ₂] (ANSI/ASHRAE Standard 62.1)	400–2500ppm: ±75ppm ³
Accuracy typical [CO ₂] _{typ.} (Operating conditions)	400–3000ppm: ±30ppm ±2% of reading ^{3, 4, 5}
Operating conditions	0–50 °C, 0–85% RH (non-condensing, dew point ≤35°C)
Warm-up time	< 10s ⁶
Response time $\tau_{63\%}$	< 40s
Resolution	1ppm
Power supply	4.5–5.25V unprotected against surges and reverse connection
Peak current	≤ 300mA
Average current, typical	≤ 18mA
Communication	UART, Modbus protocol. Direction control pin for direct connection to RS485 receiver integrated circuit.
Alarm output, open collector	 <p>1000 / 800ppm Normal state is conducting typ 10mA. Transistor open at CO₂ High, OR Power Low, OR at Sensor failure.</p>
PWM output, 1kHz	0–100% duty cycle for 0–2000ppm 3.3V push-pull CMOS output, unprotected
Pressure dependence	1.6% reading per kPa deviation from normal pressure
Compliance	ANSI/ASHRAE Standard 62.1-2022 +Addendum ab (October 31, 2023) RESET grade B WELL Building Standard® (WELL v2™) Title 24, California Energy Code
Maintenance	Maintenance-free when using Senseair ABC algorithm (Automatic Baseline Correction).
Life expectancy	> 15 years
Dimensions (LxWxH)	33.9x19.8x8.7mm
Weight	< 5g
Storage conditions	-40–70 °C

Table 1. Key technical specification for the Senseair S88 LP

- Note 1: Sensor is designed to measure in the range 400–3000ppm with specified in the table accuracy. Exposure to concentrations below 400ppm 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.
- Note 3: ANSI/ASHRAE Addendum ab to ANSI/ASHRAE Standard 62.1-2022 specifies sensor to be accurate within ±75ppm at concentrations of 600, 1000, and 2500ppm when measured at sea level at 77 °F (25 °C). See Figure 4.
- Note 4: In normal IAQ applications. Accuracy is defined after minimum three (3) ABC periods of continuous operation with ABC on. Some industrial applications do require maintenance. Contact Senseair for further information!
- Note 5: Accuracy is specified over operating temperature range. Specification is referenced to certified calibration mixtures. Uncertainty of calibration gas mixtures (±1% currently) is to be added to the specified accuracy for absolute measurements.
- Note 6: The time it takes to clear warm up bit to 0 and to provide the first measurement value.
- Note 7: See specification TDE14367 Modbus on Senseair S88.

Description

Senseair S88 LP is designed for high volume production with full traceability by sensor serial number on all manufacturing processes and key components. Every sensor is individually calibrated and is provided with UART digital interface. The sensor is maintenance-free and has an estimated lifetime of more than 15 years.

Applications

Senseair S88 LP is a module that is designed for simple integration into products. Senseair S88 LP can be used in a wide range of applications such as ventilation control to improve energy savings and to assure a good indoor climate. Other fields of use are personal safety and measurements to increase process yield and to increase economic value in bio-related processes.

Installation and soldering

See Handling manual for Senseair S8 and S88 (ANO102).

Sample gas diffusion area

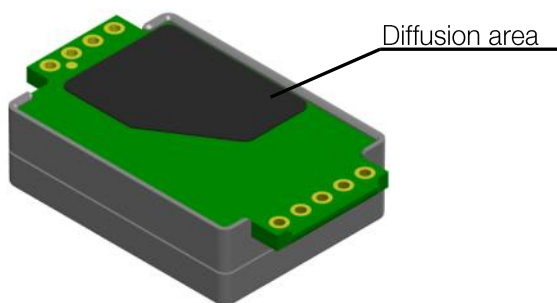


Figure 1. Diffusion area

Pin assignment



Figure 2. Pin assignment

Terminals description

The table below specifies terminals and I/O options dedicated in Senseair S88 LP model.

Pin function	Pin description / parameter description	Electrical specification
Power pins		
G0	Power supply minus terminal Sensor's reference (ground) terminal	
G+ referred to G0	Power supply plus terminal Operating voltage range	Unprotected against reverse connection! 4.5–5.25V
DVCC_out	from sensor's voltage regulator Output may be used to logical level converter if master processor runs at 5V supply voltage. Series resistance Nominal voltage Allowed source current 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 No internal protection! 3.3VDC 6mA max $\pm 0.75\%$ is typical, $\pm 3\%$ is max
Communication pins		
UART_TxD	UART data transmission line Configured as digital output Absolute max voltage range (Note 1) Internal pull up to DVCC_out resistor Output low level (Note 1) Output high level (Note 1)	No internal protection Pulled up to DVCC_out at processor reset (power up and power down) G0 - 0.3V to DVCC_out + 0.5V 120kOhm 0.5VDC max at 8mA sink 2.4VDC at 2mA source
UART_RxD	UART data receive line Configured as digital input Absolute max voltage range (Note 1) Internal pull up to DVCC_out resistor Input low level (Note 1) Input high level (Note 1)	No internal protection Pulled up to DVCC_out at processor reset (power up and power down) G0 - 0.3V to DVCC_out + 0.5V 120kOhm -0.3–0.75V 2.3V to DVCC_out + 0.3V
UART_R/T	Direction control line for half duplex RS485 transceiver like MAX485. Configured as digital output Absolute max voltage range (Note 1) Internal pull down to G0 resistor Output low level (Note 1) Output high level (Note 1)	No internal protection, Pulled down at processor reset (power up and power down) G0 - 0.3V to DVCC_out + 0.5V 120kOhm 0.5VDC max at 8mA sink 2.4VDC at 2mA source

Table 2. I/O notations, description and electrical specification (continued on next page)

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

Table 2. I/O notations, description and electrical specification (continue, see previous page).

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

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	μA	1
Maximum voltage on UART lines, PWM and bCAL_in	-0.3	DVCC_out + 0.5	V	1
Maximum voltage on Alarm_OC	-0.3	12	V	1, 3

Table 3. Absolute maximum ratings specification for the Senseair S88 LP

- 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.

Recommended operating conditions

Over operating temperature range (unless otherwise noted)

Symbol	Description	Min	Typ	Max	Unit	Test conditions
G+	Supply voltage	4.5	5	5.25	V	

Table 4. Recommended operating conditions

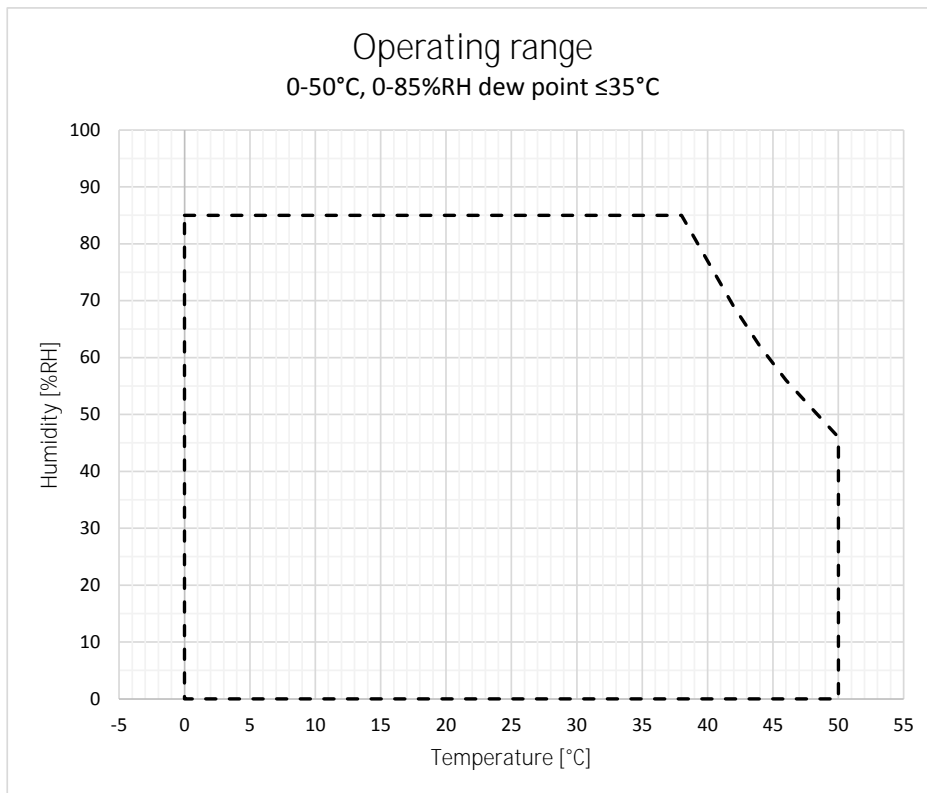


Figure 3 Operating range for specified in Table 1 accuracy.

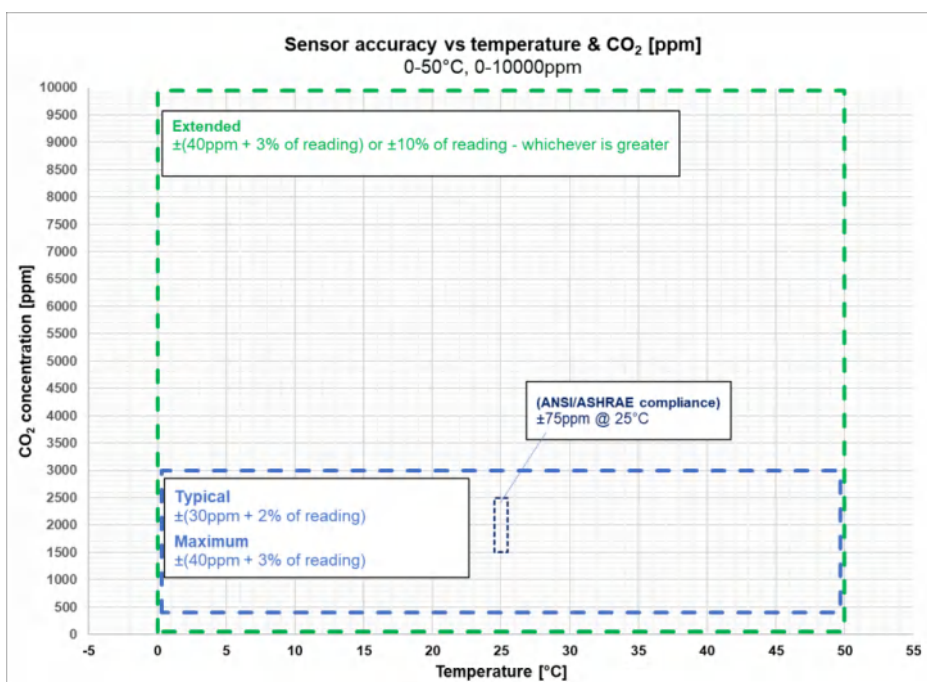


Figure 4 Accuracy over complete operating range (temperature and measurement of CO₂).

Mechanical properties

Refer to mechanical drawing for detailed specification of dimensions and tolerances.
See Handling manual for Senseair S8 and S88 (ANO102).

Installation and soldering

See Handling manual for Senseair S8 and S88 (ANO102).

Maintenance and ABC (Automatic Baseline Correction)

The models based on Senseair S88 LP platform are basically maintenance free in normal environments thanks to the built-in self-correcting **ABC algorithm**. This algorithm constantly keeps track of lowest reading of the sensor 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) CO₂.

Discuss your application with Senseair in order to get advice for a proper calibration strategy.

When checking the sensor accuracy, **NOTE** that the sensor accuracy is defined at continuous operation (at least three (3) ABC periods (see table 4) after installation with ABC turned on)!

ABC parameter	Specification
ABC period	8 days

Table 5. ABC default configuration for Senseair S88 LP

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 limited to about 30–50ppm/ABC period.

For post calibration convenience, in the event that one cannot wait for the ABC algorithm to compensate for possible 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 (400ppm CO₂) and **CAL** (zero calibration), which requires the sensor measuring cell to be completely evacuated from CO₂ e.g., by exposing it to Nitrogen or Soda Lime CO₂ 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) bCAL (background calibration) assuming 400ppm CO ₂ sensor exposure
CAL_in	(when closed for minimum 16 seconds) CAL (zero calibration) assuming 0ppm CO ₂ sensor exposure

Table 6. Switch input default configurations for Senseair S88 LP

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 port communication. *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. Contact local distributor.
1	2	Reserved	-
2	4	Algorithm error. Indicate wrong configuration.	Try to restart sensor by power OFF/ON. Check detailed settings and configuration with software tools. Contact local distributor.
3	8	Output error Detected errors during output signals calculation and generation.	Check connections and loads of outputs. Check detailed status of outputs with software tools.
4	16	Self-diagnostic error. 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 Accompanies most of other errors. Can also indicate overload or failures of sensors and inputs. Resets automatically after source of error disappearance.	Try sensor in fresh air. Perform CO ₂ background calibration. Check detailed status of measurements with software tools. See Note 1!
6	64	Memory error Error during memory operations.	Check detailed settings and configuration with software tools.
7	128	Warm Up Set to 1 until first unfiltered reading is available from the sensor.	Normal operation to have it during warm up time, see Table 1 for details.

Table 7. Error codes for Senseair S88 LP

Note 1. Any probe is out of range. It occurs, for instance, during over-exposure of CO₂ sensor, in which case the error code will automatically reset when the measurement values return to normal. It could also indicate the need of zero-point calibration. If the CO₂ 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.

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

IMPORTANT NOTICE

1. Senseair reserves the right to make changes to the information contained in this document without notice. When you consider any use or application of Senseair product stipulated in this document ("Product"), please make inquiries the sales office of Senseair or authorised distributors as to current status of the Products.
2. All information included in this document are provided only to illustrate the operation and application examples of Senseair Products. Senseair neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of Senseair or any third party with respect to the information in this document. You are fully responsible for use of such information contained in this document in your product design or applications. **SENSEAIR ASSUMES NO LIABILITY FOR ANY LOSSES INCURRED BY YOU OR THIRD PARTIES ARISING FROM THE USE OF SUCH INFORMATION IN YOUR PRODUCT DESIGN OR APPLICATIONS.**
3. The Product is neither intended nor warranted for use in equipment or systems that require extraordinarily high levels of quality and/or reliability and/or a malfunction or failure of which may cause loss of human life, bodily injury, serious property damage or serious public impact, including but not limited to, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signalling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. Do not use Product for the above use unless specifically agreed by Senseair in writing.
4. Though Senseair works continually to improve the Product's quality and reliability, you are responsible for complying with safety standards and for providing adequate designs and safeguards for your hardware, software and systems which minimise risk and avoid situations in which a malfunction or failure of the Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption.
5. Do not use or otherwise make available the Product or related technology or any information contained in this document for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). When exporting the Products or related technology or any information contained in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. The Products and related technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
6. Please contact Senseair sales representative for details as to environmental matters such as the RoHS compatibility of the Product. Please use the Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Senseair assumes no liability for damages or losses occurring as a result of noncompliance with applicable laws and regulations.
7. Resale of the Product with provisions different from the statement and/or technical features set forth in this document shall immediately void any warranty granted by Senseair for the Product and shall not create or extend in any manner whatsoever, any liability of Senseair.
8. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Senseair.

www.senseair.com