# Product Specification

# eSENSE

Carbon dioxide sensor in a housing


## General

eSENSE is a simple, low cost, state-of-the-art, maintenance-free carbon dioxide transmitter for installation in the climate zone or in the ventilation duct.
eSENSE measures the carbon dioxide concentration in the ambient air, using infrared technology, up to 2000ppm, and transforms the data into an analogue output.

| Item | eSENSE |
|---|---|
| Target gas | Carbon dioxide ($CO_2$) |
| Operating Principle | Non-dispersive infrared (NDIR) |
| Measurement range<br><br>OUT1<br><br>OUT2 | 0 — 2000ppm$_{vol}$ [1]<br><br>0 — 10V for 0 — 2000ppm<br>±2% of reading ±20mV<br><br>2 — 10V (or 4 — 20 mA) for 0 — 2000ppm<br>±2% of reading ±20mV |
| Accuracy | ±30ppm ±3% of reading [1, 2] |
| Response time (T1/e) | <10sec. @ 30 cc/min. flow rate, <3min. diffusion time |
| Rate of Measurement | 0.5Hz |
| Operating environment | Residential, commercial and industrial spaces [3] |
| Operating temperature | 0 — 50°C |
| Operating humidity | 0 — 95%RH non condensing |
| Storage temperature | -40 — 70°C (display model (*Disp*): -20 — 50°C) [3] |
| Dimensions (mm) | *See housing options below* |
| Power supply | 24VAC/VDC ±20%, 50Hz (half-wave rectifier input) |
| Warm Up time to spec. precision | 1min (@ full specs <15min) |
| Life expectancy | >15 years [4] |
| Serial communication | UART |
| OUT 1 | Linear Conversion Range: 0 — 10V for 0 — 2000ppm [1]<br>Electrical Characteristics: $R_{OUT}$ <100Ω $R_{LOAD}$ >5kΩ<br>D/A conversion accuracy: ±2% of reading ±20mV<br>D/A Resolution: 10mV (10 bit) |
| OUT 2 | Linear Conversion Range: 2 — 10V (or 4 — 20mA) for<br>0 — 2000ppm [1]<br>Electrical Characteristics: $R_{OUT}$ < 100Ω $R_{LOAD}$ > 5kΩ<br>D/A conversion accuracy: ±2% of reading ±0.3mA<br>D/A Resolution: 0.02mA (10 bit) |
| Thermistor outputs | Temperature measurement resistor terminal output with signal return connected to ground terminal (option TR) [5] |
| Maintenance | Maintenance-free with using Senseair ABC logic Self calibration using for normal indoor applications [4, 6] |

Table 1: Key technical specification for the eSENSE

Note 1: Extended range up to 10000ppm ±10%
Note 2: Accuracy is defined after zero calibration or after minimum three (3) ABC periods of continuous operation.
Note 3: All corrosive environments are excluded.
Note 4: In normal Indoor Air Quality (IAQ) applications @ NTP (25 C, 101.3kPa).
Note 5: Resistive probe is to be mounted by the user. Can be factory pre-mounted upon request.
Note 6: Requires fresh air (400ppm) once every ABC period.

# Terminal descriptions

The table below specifies what terminals and I/O options are available in the general *K50 sensor platform*. Please note, that in the eSENSE default configuration, only G+, G0, OUT1 and OUT2 have any pre-programmed functions.

| Functional group | Descriptions and ratings |
|---|---|
| **Power supply** | |
| G+ | Power supply voltage may be AC or DC. Positive pole of DC power supply shall be connected to G+. Sensor performs half wave rectification of supplied AC voltage. Power supply lines are protected by varistor from voltage spikes and over voltage. Serial 3R3 resistor limits start up inrush current.<br>Nominal specification:<br>24VAC ±20%<br>24VDC ±20%<br>Absolute maximum ratings 16.5 — 40VDC |
| G0 | Connected to sensor's ground.<br>Negative pole connection for DC power supply |
| **Serial Communication** | |
| UART (TxD, RxD) | Optional, available on from JP2<br>5V CMOS logical levels, ModBus communication protocol.<br>Logical levels corresponds 5V powered logics.<br><br>Protection 56R resistors are added on RxD and TxD lines<br>RxD line is configured as digital input. Input high level is 2.1V min<br>Input low level is 0.8V max<br>TxD line is configured as digital output. Output high level is 4.0V<br>Output low level is 0.75V max<br>RxD input is pulled up to DVCC = 5V by 56kΩ<br>TxD output is pulled up to DVCC = 5V by 56kΩ |
| **Outputs** | |
| OUT1 | Buffered linear output 0 to 10V or 2 to 10V, or any other voltage span within 0 to 10V range, depending on sensor configuration.<br>Resolution 10mV. |
| OUT2 | Buffered linear output 0 — 10V or 2 — 10V alternatively 0 — 20 mA or 4 to 20mA, or any other voltage/current span within 0 — 10V/0 — 20mA range, depending on sensor configuration.<br>Resolution 10mV/0.02mA<br><br>Choice of Voltage/Current output may be hardwired or provided by "Config jumper" JP6. The choice may be soldered by 0R resistors.<br><br>This output can be used as alternative for OUT1, or for a second data channel, or in an independent linear control loop, such as a housing temperature stabilization |
| **Indicators** | |
| 2 colour LED (OUT3 and OUT4) | OUT3 and OUT4 can drive two colour LED placed under display adjacent to yellow LED.<br><br>Can be used for gas alarm indication, or for status indication etc. |
| Status LED | Yellow LED is dedicated to indicate status of the sensor.<br><br>Lights yellow at heating phase after power up and if status byte is not zero.<br>See detailed description of status byte in "Error code and action plan (error code can be read via one of communication channels)" |
| LCD | LCD is dedicated to represent measured values and status of the sensor.<br>List of represented values and format are defined by particular model configuration. |
| NTC | This terminal is potential free and is connected to the upper pole of JP10 |

Table 2: Terminal descriptions for eSENSE™

# Housing options

WALL HOUSING (standard)
**With or without display.**
eSENSE: Dim.: 100 x 80 x 28mm (H x W x D)
Protection class: IP30
60mm hole separation for European standard J-boxes.

eSENSE II: Dim.: 130 x 85 x 30mm (H x W x D)
Protection class: IP30
Fits US standard J-boxes.

INDUSTRIAL WALL HOUSING
**With or without display**
Dim.: 142 x 84 x 46mm (H x W x D)
Protection class: IP54

DUCT HOUSING
Protection class: IP65
Duct probe length: 245mm
(adjustable according to duct dimension)

ALL-ROUND HOUSING
Dim.: 106 x 67 x 26mm (H x W x D)
Protection class: IP50
Connection: 34cm 3-wire pigtail (no OUT2)
For wall and duct applications.


eSENSE Disp | eSENSE II Disp | eSENSE Duct Disp | eSENSE Ind Disp | eSENSE Slim

Figure 1: Housing options

# Calibrations

The default eSENSE is maintenance free in normal environments thanks to the built-in self-correcting ABC algorithm (Automatic Baseline Correction). This algorithm constantly keeps track of the lowest reading of the sensor over a 7.5 days interval and slowly corrects for any long-term drift detected as compared to the expected fresh air value of 400ppm $CO_2$.

Rough handling and transportation might, however, 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 30ppm/week. For post calibration convenience, in the event that one cannot wait for the ABC algorithm to cure any calibration offset, two switch inputs DigIn2 and DigIn3 are defined for the operator to select one out of two prepared calibration codes. If DigIn3 is shorted, for a minimum time of 8 seconds, the internal calibration code **bCAL** *(background calibration)* is executed, it is assumed that the sensor is operating in a fresh air environment (400ppm $CO_2$). If DigIn2 is shorted instead, for a minimum time of 8 seconds, the alternative operation code **CAL** *(zero calibration)* is executed, in which case the sensor must be purged by some gas mixture free from $CO_2$ (i.e. Nitrogen or Soda Lime $CO_2$ scrubbed air). If unsuccessful, please wait at least 10 seconds before repeating the procedure again. Make sure that the sensor environment is steady and calm!

| Input Switch Terminal *(normally open)* | Default function (when closed for minimum 8 seconds) |
|---|---|
| Din3 | **bCAL** (background calibration) assuming 400ppm $CO_2$ sensor exposure |
| Din2 | **CAL** (zero calibration) assuming 0ppm $CO_2$ sensor exposure |

Table 3: Switch input default configurations for eSENSE

## 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. If this byte is not zero, the LED **Status** will be put into Low level state. The full error codes are available from the UART port or via I²C communication. *Offset regulation error* and *Out of Range* are the only bits that are 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.

| LED | Default function |
|---|---|
| Status / Yellow | **OFF** = OK, **Lit** = Fault |

Table 4: Default Logic output configured for eSENSE

## Maintenance

The eSENSE is basically maintenance free in normal environments thanks to the built-in self-correcting ABC algorithm. 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 (three (3) ABC periods after installation)!

## Installations

The modules are factory calibrated and ready for use directly after power up. There are several alternative ways to connect the eSENSE to a host system (see also installation manual for the actual product):

Do not use edge connector for connection to the host system without discussion with Senseair!

1. Using “UART connector” UART (TxD, RxD)
2. Using the 4 pins **main terminal**. Available signals are power supply (G+ and G0) and the buffered analogue outputs (OUT1, OUT2).

**Note:** The terminals are not protected against reverse voltages and current spikes! Proper ESD protection is required during handling, as well as by the host interface design.

## Default functions / configurations

Outputs

The basic eSENSE configuration is a simple analogue output sensor transmitter signal directed to OUT1 and OUT2. Via the serial communication terminal, the $CO_2$ readings are available to an even higher precision, together with additional system information such as sensor status, analogue outputs, and other variables.

The user can modify the output ranges at any time using a dedicated development kit, including PC software and a special serial communication cable.

| Terminals | Output | Correspondence |
|---|---|---|
| OUT1 | 0 — 10,0VDC | 0 — 2000ppm $CO_2$ [1] |
| OUT2 | 2.0 — 10.0 VDC or<br>4.0 — 20.0mA | 0 — 2000ppm $CO_2$ [1] |
| | 0.9 — 1.6VDC<br>or<br>1.5 — 2.5mA | Status = ERROR |
| | 0VDC or 0mA | Status = NOT READY |

Table 5: Default analogue output configuration for eSENSE

Note 1: eSENSE ext. range 10000ppm: 0 — 10000ppm

## Error codes and action plans

(Error code can be read via one of communication channels)

| 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 | Offset regulation error | Try to restart sensor by power OFF/ON.<br>Contact local distributor. |
| 2 | 4 | Algorithm Error.<br>Indicate wrong EEPROM 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. | Check connections of temperature and relative humidity probe (if mounted).<br>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: Key Error code and action plan for the eSENSE

Note 1*:* Any probe is out of range. It 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. It could also indicate the need of zero point calibration. If the $CO_2$ readings are normal, and still the error code remains, the temperature sensor can be defect or the connections to it are broken.

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

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