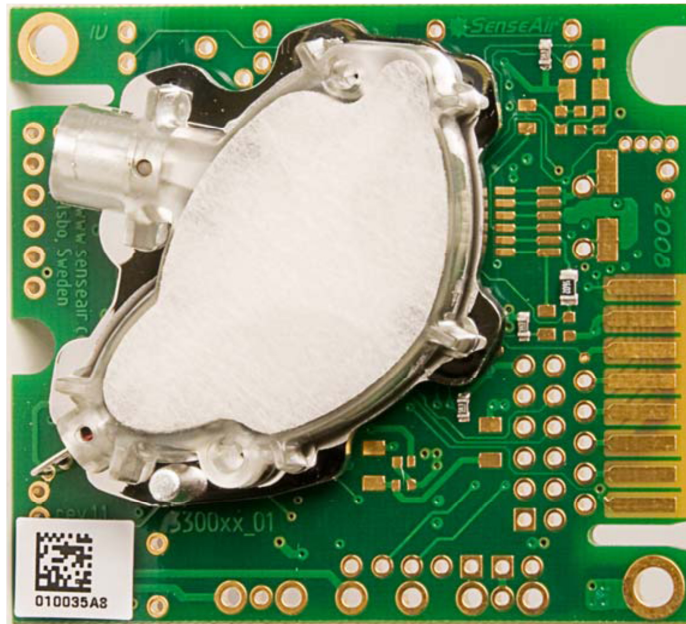


## Product Specification

# *CO<sub>2</sub> Engine<sup>®</sup> K33-LP T*

Sensor Module and OEM Platform



## General

The **K33** sensor platform **CO<sub>2</sub> Engine® K33-LP** is designed to be a low power OEM module for built-in applications in a host apparatus, and hence should be optimized for its tasks during a dialog between SenseAir and the OEM customer. This document is to be considered as the starting point for such a dialog.

	Item	<b>CO<sub>2</sub> Engine® K33-LP T*</b> Art. no.: 033-8-0008
<b>General performance</b>	<b>Target gas</b>	Carbon dioxide (CO <sub>2</sub> )
	<b>Storage temperature range</b>	-30 to +70 °C
	<b>Storage environment</b>	Non condensing, non corrosive environment
	<b>Operating environment</b>	Residential, commercial and industrial spaces <sup>1</sup>
	<b>Operating temperature range</b>	0 to +50 °C
	<b>Life expectancy</b>	>15 years
	<b>Maintenance</b>	Maintenance-free with using SenseAir ABC logic self calibration <sup>2</sup>
	<b>Compliance with</b>	RoHS directive 2002/95/EG
<b>Electrical / Mechanical</b>	<b>Power supply</b>	4,75 to 12.0 VDC maximum rating, powered via Vbat+
		5.50 to 12.0 VDC maximum rating, powered via G+
	<b>Average current consumption</b>	<1.5mA with 30s measurement period
	<b>Peak current consumption</b>	<300mA
	<b>Electrical connections</b>	Vbat+, G+ and G0
	<b>Dimensions (mm)</b>	51 x 57 x 12.5 mm (Length x Width x Height)

<sup>1</sup> SO<sub>2</sub> enriched environments excluded

<sup>2</sup> ABC logic is enabled in sensors default configuration

<b>CO<sub>2</sub> measurement</b>	<b>Operating principle</b>	Non-dispersive infrared (NDIR)
	<b>CO<sub>2</sub> operating range (temperature/humidity)</b>	<p>The graph plots Relative Humidity (RH) in percent on the y-axis (0 to 100) against Temperature in degrees Celsius on the x-axis (0 to 50). Two shaded regions represent the operating ranges. The 'Operating range' (solid blue) starts at 80% RH at 0°C and gradually decreases to approximately 70% RH at 50°C. The 'Extended operating range' (hatched blue) starts at 90% RH at 0°C and decreases to approximately 80% RH at 50°C.</p>
	<b>Sampling method</b>	Diffusion
	<b>Response time (T<sub>1/e</sub>)</b>	<1 min, 30s measurement period, unfiltered
	<b>Response time (T<sub>1/e</sub>)</b>	<3 min, 30s measurement period, frac filter enabled <sup>3</sup>
	<b>Measurement period</b>	Default 30s, configurable, contact SenseAir for information about possible configurations
	<b>Measurement range</b>	0 to 5000 ppm <sub>vol</sub>
	<b>Accuracy</b>	±30 ppm ±3% of measured value, frac filter enabled <sup>4 5</sup>
	<b>Repeatability</b>	±20 ppm ±1% of measured value, frac filter enabled
	<b>Extended measurement range</b>	5000 to 10000 ppm <sub>vol</sub>
	<b>Accuracy, extended measurement range</b>	Typically <(±30 ppm ±20% of measured value) (within CO <sub>2</sub> operating temperature/humidity range)
	<b>Accuracy, extended operating range</b>	Typically <(±30 ppm ±20% of measured value)
	<b>Pressure dependence</b>	+1.6% reading per kPa deviation from normal pressure
<b>Warm up time to spec precision</b>	<3 min, 30s measurement period, frac filter enabled	

<sup>3</sup> Frac filter (digital filter) is enabled in sensors default configuration

<sup>4</sup> Accuracy is specified over operating temperature range at normal pressure 101.3 kPa. 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.

<sup>5</sup> Accuracy is defined after minimum 3 weeks of continuous operation with ABC logic self calibration enabled (default configuration)

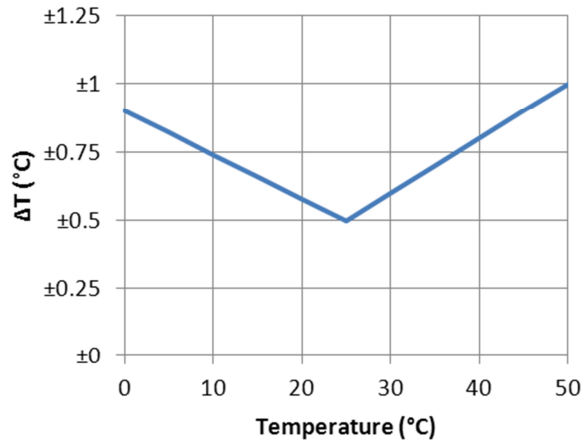
<b>Outputs and communication</b>	<b>OUT 1 (OC)</b>	Open collector output											
	<b>Serial communication</b>	UART, Modbus protocol											
	<b>I2C communication</b>	I2C											
<b>Logger properties</b>	<b>Logger capacity</b>	5400 logging points											
<b>Temperature measurement</b>	<b>Temperature measurement range</b>	0 to 50 °C											
	<b>Temperature measurement accuracy</b>	 <p>The graph plots measurement accuracy (ΔT in °C) on the y-axis against temperature (°C) on the x-axis. The y-axis ranges from ±0 to ±1.25 with increments of 0.25. The x-axis ranges from 0 to 50 with increments of 10. A blue line shows the accuracy, which is ±0.5 °C at 25 °C, ±0.75 °C at 10 °C and 40 °C, and ±1.0 °C at 0 °C and 50 °C.</p> <table border="1"> <thead> <tr> <th>Temperature (°C)</th> <th>Accuracy (ΔT in °C)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>±1.0</td> </tr> <tr> <td>10</td> <td>±0.75</td> </tr> <tr> <td>25</td> <td>±0.5</td> </tr> <tr> <td>40</td> <td>±0.75</td> </tr> <tr> <td>50</td> <td>±1.0</td> </tr> </tbody> </table>	Temperature (°C)	Accuracy (ΔT in °C)	0	±1.0	10	±0.75	25	±0.5	40	±0.75	50
Temperature (°C)	Accuracy (ΔT in °C)												
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Table I. Key technical specification for *CO<sub>2</sub> Engine<sup>®</sup> K33-LP T*

## Terminal descriptions

The table below specifies what terminals and I/O options are available in the general **K33** platform (see also figure 1-5).

Functional group	Descriptions and ratings
<b>Power supply</b>	
G+ referred to G0:	Absolute maximum ratings 5.5 to 12V, stabilized to within 5% 6.0 to 9V preferred operating range. Protected against transients on G+, limited protection against reverse polarity (can withstand reverse polarity temporarily)
Vbat+ referred to G0	Absolute maximum ratings 4.75 to 12V, stabilized to within 5% 6.0 to 9V preferred operating range.
DVCC = 3.3V	Output from sensor's digital voltage regulator. Series resistance                      10 R Available current                        12mA Voltage tolerance (unloaded)        +-3% max (+-0.75% typ) Output may be used to power circuit (microcontroller) in host system or to power logical level converter if master processor runs at 5V supply voltage.
<b>Outputs</b>	
OUT1 (OC)	Digital output, open collector  Series resistance                        120 R Max sink current                         40mA  May be used as alarm indication, configurable output behavior (UIP5).
OUT5-OUT8	Optional, can be used to drive LEDs, configurable output behavior ( UIP5).
OUT9	Optional, can be used to control a relay, configurable output behavior ( UIP5).
<b>Serial Communication</b>	
UART (TxD, RxD)	CMOS physical layer, ModBus communication protocol. Logical levels corresponds 3.3V powered logics. Refer " <i>ModBus on CO2 Engine K30</i> " for electrical specification.  UART_RxD line is configured as digital input. Input high level is 2.1V min Input low level is 0.8V max  UART_TxD line is configured as digital output. Output high level is 2.3V (assuming 3.3V DVCC) min Output low level is 0.75V max  UART_RxD input is pulled up to DVCC = 3.3V by 56 kOhm UART_TxD output is pulled up to DVCC = 3.3V by 56 kOhm  <b>ABSOLUTE MAX RATING            G0-0.5V    .....    DVCC + 0.5V</b>
<b>I<sup>2</sup>C extension.</b>	
I2C (SDA, SCL)	Pull-up of SDA and SCL lines to 3.3V. (refer "I2C comm guide 2_15.pdf" or later version for details)  <b>ABSOLUTE MAX RATING            G0-0.5V    .....    DVCC + 0.5V</b>

<b>Inputs &amp; Optional jumper field</b>	
Din0 Din1 Din2 Din3,	<p>Digital switch inputs have pull-up 56k to DVCC 3.3V most of the time. Pull-up resistance is decreased to 4..10k only during read of input / jumper to provide cleaning of the contacts by larger currents. They are the same as inputs on IDC connector.</p> <p>Din1 is used for background calibration. Din2 is used for zero calibration. Din3 can be used as R/T pin for a RS485 driver (not default configuration, contact SenseAir for more information)</p>

*Table II. I/O notations used in this document for the K33 platform with some descriptions and ratings. Please, beware of **the red colored texts that pinpoint important features** for the system integration!*

# General PCB overview

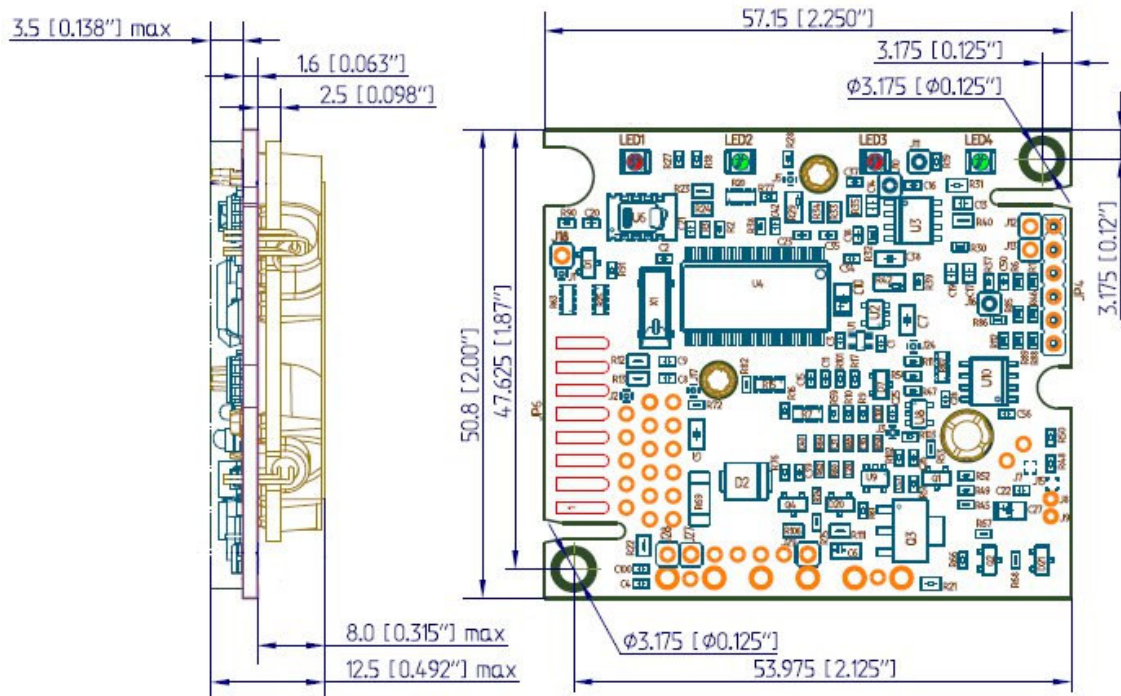


Figure 1, CO<sub>2</sub> Engine®K33-LP mechanical dimensions

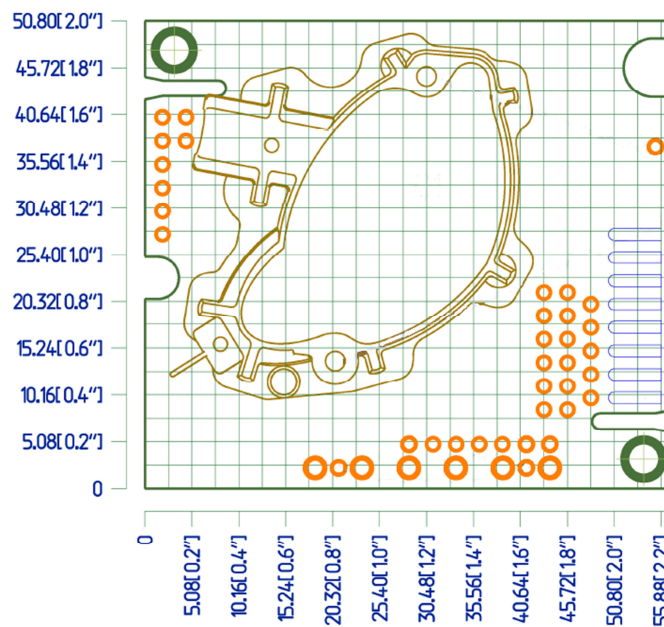


Figure 2, CO<sub>2</sub> Engine®K33-LP OBA and connector positions

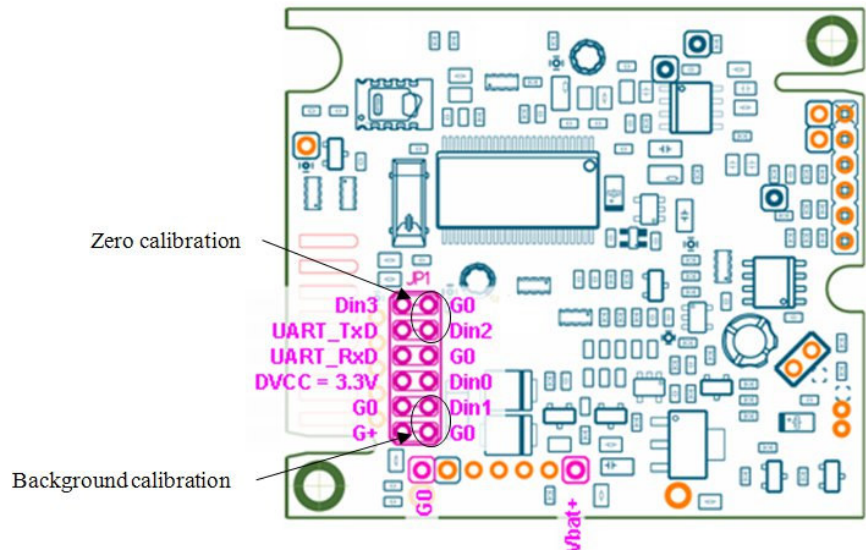


Figure 3, CO<sub>2</sub> Engine<sup>®</sup> K33-LP (component side) zero and background calibration inputs



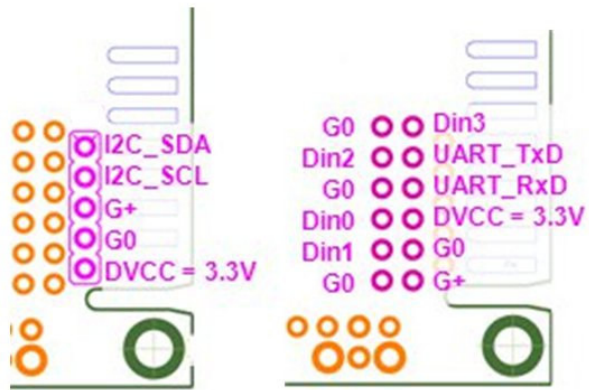


Figure 4, *CO<sub>2</sub> Engine<sup>®</sup>K33-LP* (OBA side) supply, UART and I2C connections

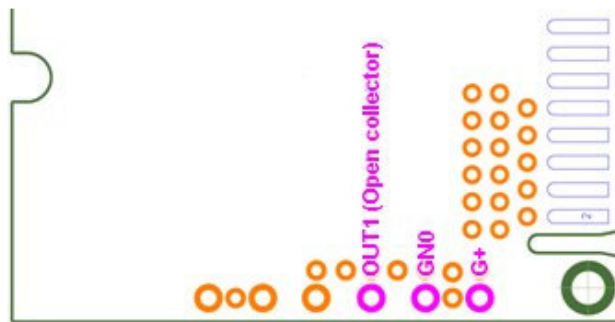


Figure 5, *CO<sub>2</sub> Engine<sup>®</sup>K33-LP* (OBA side) G+, GND and OUT1, 5.12mm hole spacing

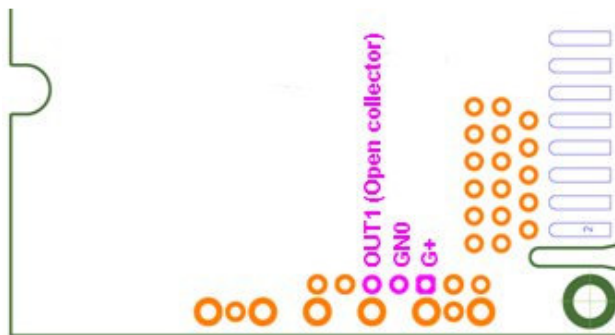


Figure 6, *CO<sub>2</sub> Engine<sup>®</sup>K33-LP* (OBA side) G+, GND and OUT1, 2.54mm hole spacing

## Ground / Shield attachments

Both analog ground (AGND) and digital ground (DGND) are connected internally to the G0 terminal of the sensor. AGND is connected to the most sensitive analog part of the sensor and DGND is connected to the digital part of the sensor.

**Do NOT connect AGND and DGND together externally to the sensor**

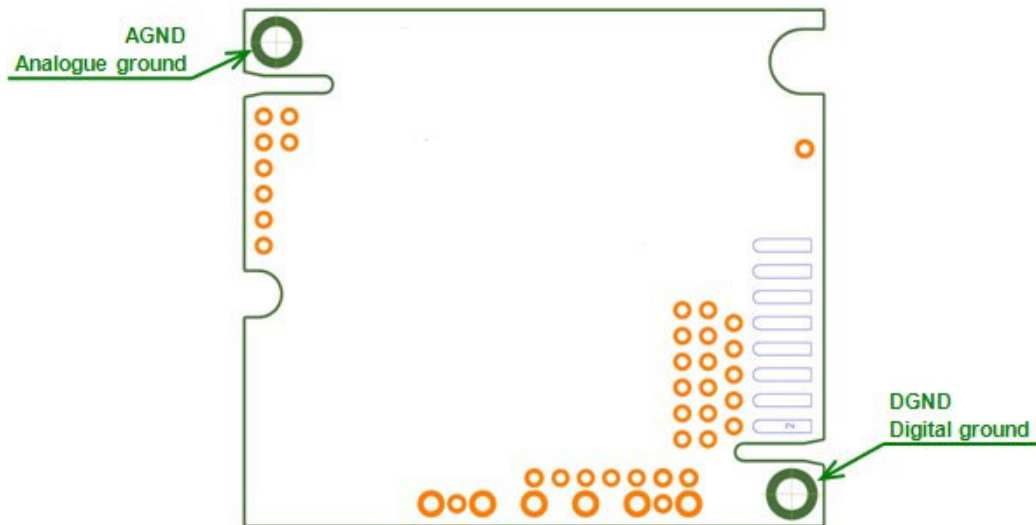


Figure 7, CO<sub>2</sub> Engine<sup>®</sup> K33-LP (OBA side) AGND and DGND

# Calibration

## Background calibration restore switch Din1

For highest possible accuracy, the sensor can be re-calibrated just before the important measurement is to be carried out. This is possible to do by a qualified operator, provided that the sensor is exposed to a reference gas, which by default should contain exactly 400 ppm CO<sub>2</sub>.

During a calibration process the sensor must be carefully exposed to the calibration gas in a manner that assure no dilution air of the reference gas from the ambient, and that no overpressure is created in the sensor sample cell. One way to achieve this is to position the sensor in a deep and soft plastic bag and flush the reference gas inside this bag for a while.

Creating an electrical shortcut between Din1 and GND actuates the calibration process. As soon as the micro-controller detects this manually grounded switch terminal, a new zero constant sensor parameter is calculated replacing the old parameter, so as to push the current sensor reading to what is being defined for the reference gas (default = 400 ppm CO<sub>2</sub>).

If the operator leaves the sensor with Din1 closed for some period of time, the sensor will continue to recalibrate for the 400 ppm target value until the switch closure eventually is released.

## Zero calibration restore switch Din2

The Din2 switch operates exactly in the same way as the Din1 switch, but assumes that the reference gas contains no carbon dioxide at all, such as nitrogen, for instance. Hence, a calibration executed by shorting the Din2 switch performs a true zero point calibration adjustment.

Input Switch Terminal (normally open)	Default function (when closed for minimum one measurement cycle)
Din1	<b>bCAL</b> (background calibration) assuming 400 ppm CO <sub>2</sub> sensor exposure
Din2	<b>CAL</b> (zero calibration) assuming 0 ppm CO <sub>2</sub> sensor exposure

Table III. Switch input default configurations for **CO<sub>2</sub> Engine® K33-LP**

## ABC algorithm

The default sensor OEM unit 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 sensor's lowest reading over a 7.5 days interval and slowly corrects for any long-term drift detected as compared to the expected fresh air value of 400 ppm CO<sub>2</sub>.

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

# Maintenance

The **CO<sub>2</sub> Engine® K33-LP** 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.

## Self-diagnostics

The system contains self-diagnostic procedures. A 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. These different system checks return error bytes to the system RAM. The full error codes are available from the UART port or via I<sup>2</sup>C 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.

## Error code and action plan (error code can be read via one of communication channels)

Bit #	Error code	Error description	Suggested action
0	1	<b>Fatal Error</b>	Try to restart sensor by power OFF/ON. Contact local distributor.
1	2	<b>Offset regulation error</b>	Try to restart sensor by power OFF/ON. Contact local distributor.
2	4		
3	8		
4	16	<b>Detector temperature out of range</b> Indicates to high/low (out of range) detector temperature.	Check detailed self-diagnostic status with software tools. Contact local distributor.
5	32	<b>CO<sub>2</sub> out of range</b> Measured CO <sub>2</sub> value is out of range.	Try sensor in fresh air. Perform background or zero calibration. Contact local distributor.
6	64	<b>Memory Error</b> Error during memory operations.	Try to restart sensor by power OFF/ON. Contact local distributor.
7	128	<b>Space temperature out of range</b> Indicates to high/low (out of range) temperature.	Try sensor in 0..50 °C. Contact local distributor.

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

The product and product specification are subject to change without notice. Contact SenseAir to confirm that the information in this product description is up to date.

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