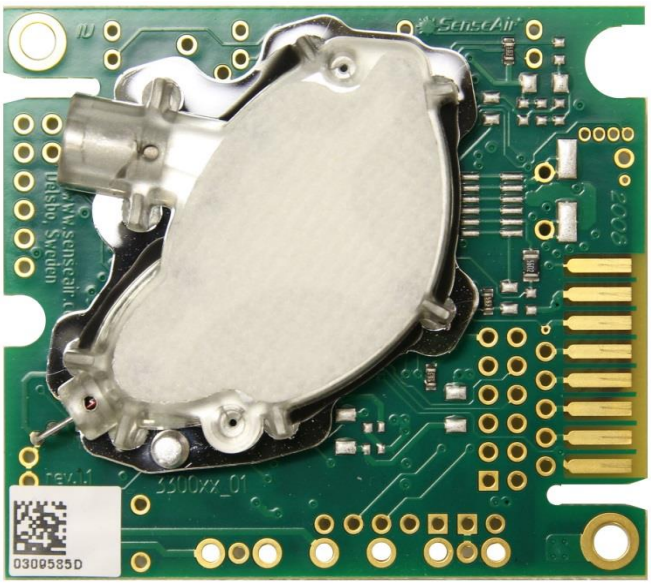
Sensors for Life

Product Specification

CO_2 Engine® K33-LP T/RH

Sensor Module and OEM Platform

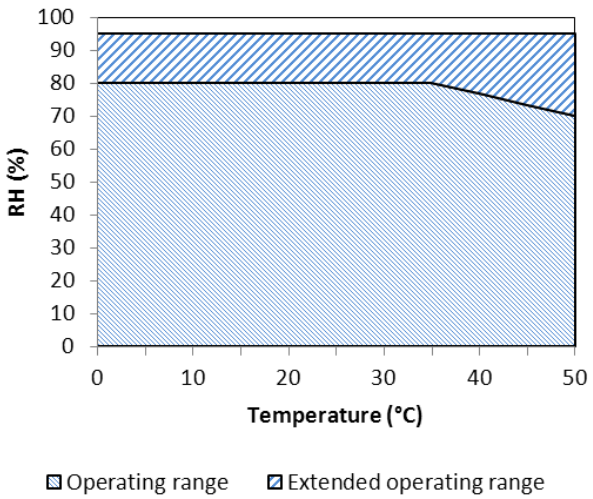


General

The K33 sensor platform CO2 Engine® K33-LP T/RH 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	**CO_2 Engine® K33-LP T/RH Art. no:. 033-8-0009**
General performance	
Target Gas	Carbon dioxide (CO_2)
Storage Temperature Range	-30 to +70 °C
Sensor Life Expectancy	>15 years
Maintenance	Maintenance-free with enabled ABC[1]
Compliance with	RoHS directive 2011/65/EU
Operating Temperature Range	0 to +50 °C
Storage environment	Non condensing, non corrosive environment
Operating Environment	Residential, commercial and industrial spaces [2]
Electrical / Mechanical	
Power Supply	4,75 to 12.0 VDC maximum rating, powered via Vbat+ 5.50 to 12.0 VDC maximum rating, powered via G+
Average current consumption	<1.5mA, 30s measurement period (default setting) <0.75mA, 60s measurement period
Peak current consumption	<300mA
Electrical Connections [3]	Vbat+, G+ and G0
Dimensions (mm)	51 x 57 x 12.5 mm (Length x Width x Height)
CO_2 measurement [4]	
Operating principle	Non-dispersive infrared (NDIR)

[1] ABC is enabled in default configuration
[2] SO_2 enriched environments excluded
[3] Different options exist and can be customized depending on the application. Please contact SenseAir for further information!

Item	CO_2 Engine® K33-LP T/RH Art. no:. 033-8-0009
CO_2 operating temperature/ humidity range	
Sampling Method	diffusion
Response Time ($T_{1/e}$)	<1 min, 30s measurement period
Response Time ($T_{1/e}$)	<3 min, 30s measurement period, frac filter enabled [4]
Measurement Period	Default 30s, configurable, contact SenseAir for information about possible configurations
Measurement range	0 to 5000 ppm_{vol}
Accuracy	±30 ppm ±3% of measured value, frac filter enabled [5] [6]
Repeatability	±20 ppm ±1% of measured value, frac filter enabled
Extended measurement range	5000 to 10000 ppm_{vol}
Accuracy, extended measurement range	Typically <(±30 ppm ±20% of measured value) (within CO_2 operating temperature/humidity range)
Pressure dependence	+1.6% reading per kPa deviation from normal pressure
Warm up time to spec precision	<3 min, 30s measurement period, frac filter enabled
Outputs and communication	
OUT 1 (OC)	Open collector output
Serial communication	UART, Modbus protocol
I_2C communication	I_2C
Logger properties	
Logger capacity	5400 logging points
Temperature measurement	

[4] Frac filter (digital filter) is enabled in sensors default configuration

[5] 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.

[6] Accuracy is defined after minimum 3 weeks of continuous operation with enabled ABC (default configuration)

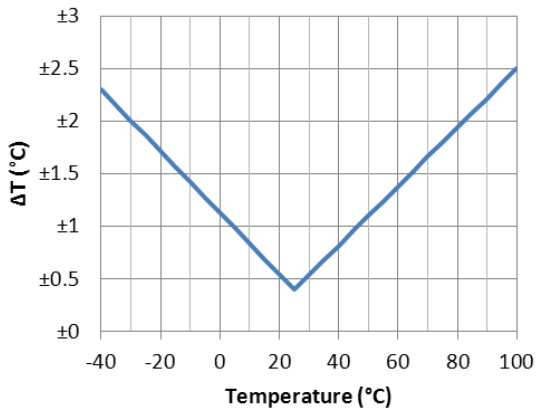
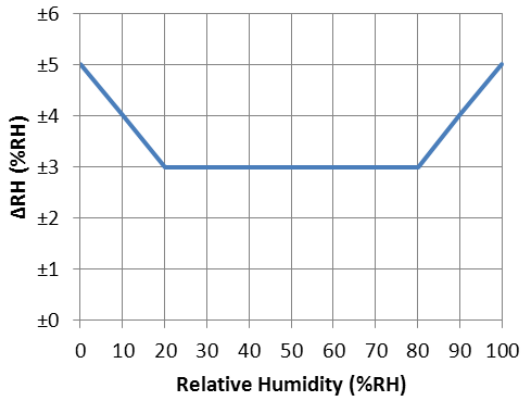
Item	CO_2 Engine® K33-LP T/RH Art. no:. 033-8-0009
Temperature sensor	Sensirion SHT11
Temperature measurement range	0 to 50°C (operating range for Sensirion SHT11 is -40 to 100°C)
Temperature measurement accuracy	
Relative humidity measurement	
RH sensor	Sensirion SHT11
RH measurement range	0 to 100% RH (non condensing)
RH accuracy	

Table 1. Key technical specification for CO_2 Engine® K33-LP T/RH

Terminal descriptions

The table below specifies what terminals and I/O options are available in the general **K33** platform *(see also figure 1-5)*. Please note, however, that in the *CO_2 Engine® K33-LP T/RH* default configuration, only Din1 and Din2 have any pre-programmed functions.

Functional group	Descriptions and ratings
Power supply	
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.
Outputs	
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).
Serial Communication	
UART (TxD, RxD)	CMOS physical layer, ModBus communication protocol. Logical levels corresponds 3.3V powered logics. Refer *"ModBus on CO2 Engine K30"* 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 **ABSOLUTE MAX RATING G0-0.5V ….. DVCC + 0.5V**

Functional group	Descriptions and ratings
I^2C extension.	
I^2C (SDA, SCL)	Pull-up of SDA and SCL lines to 3.3V. (refer “I2C comm guide 2_15.pdf” or later version for details) **ABSOLUTE MAX RATING G0-0.5V ….. DVCC + 0.5V**
Inputs & Optional jumper field	
Din0 Din1 Din2 Din3,	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. 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)

Table 2. 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

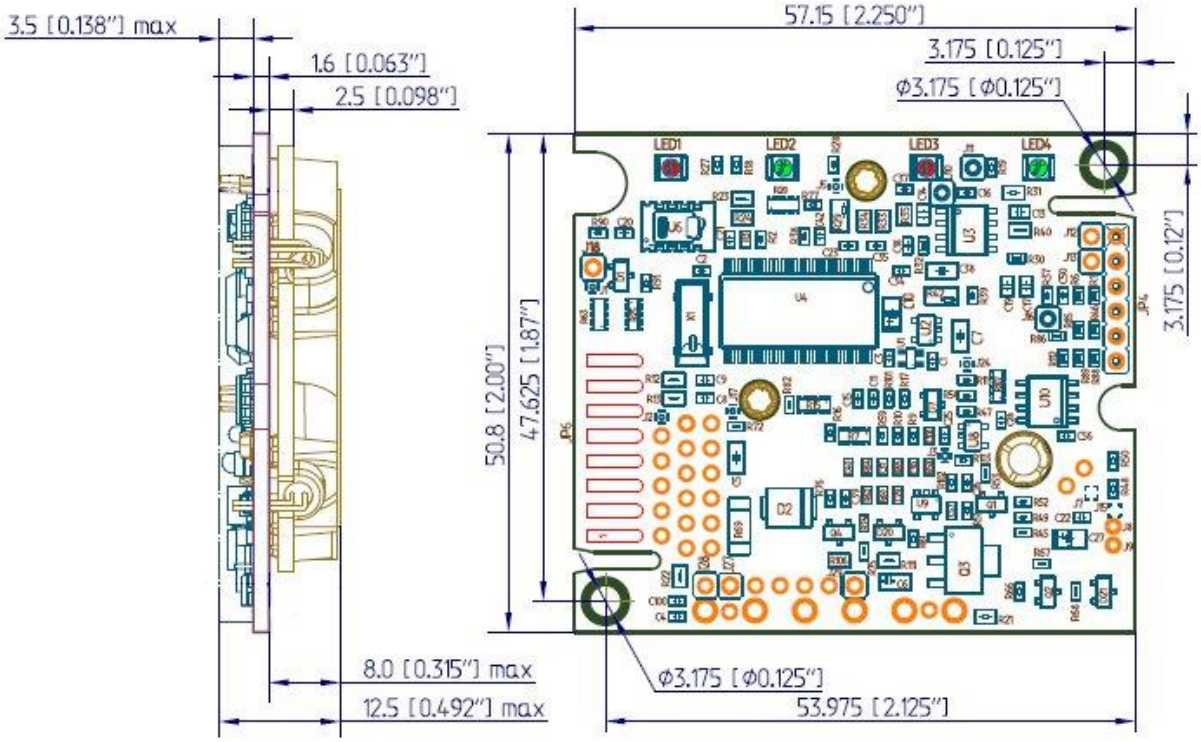


Figure 1. CO_2 Engine® K33-LP T/RH mechanical dimensions

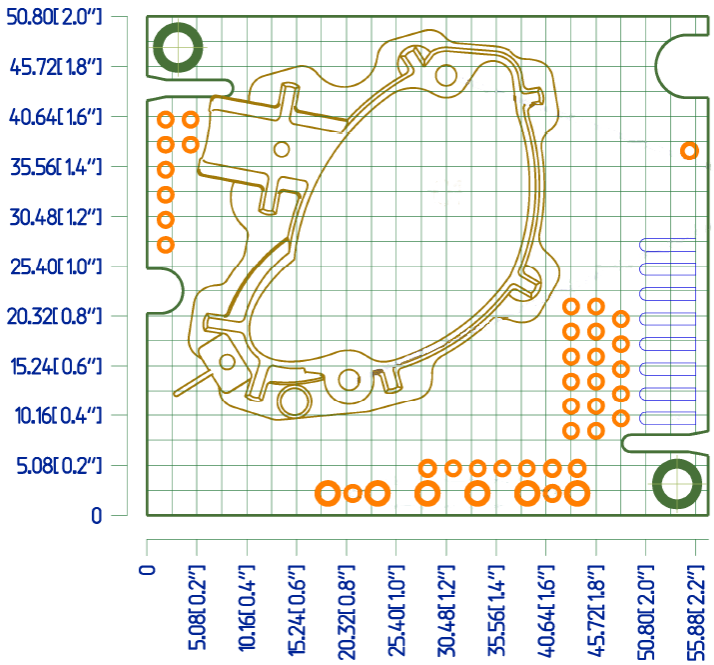


Figure 2. CO_2 Engine® K33-LP T/RH OBA and connector positions

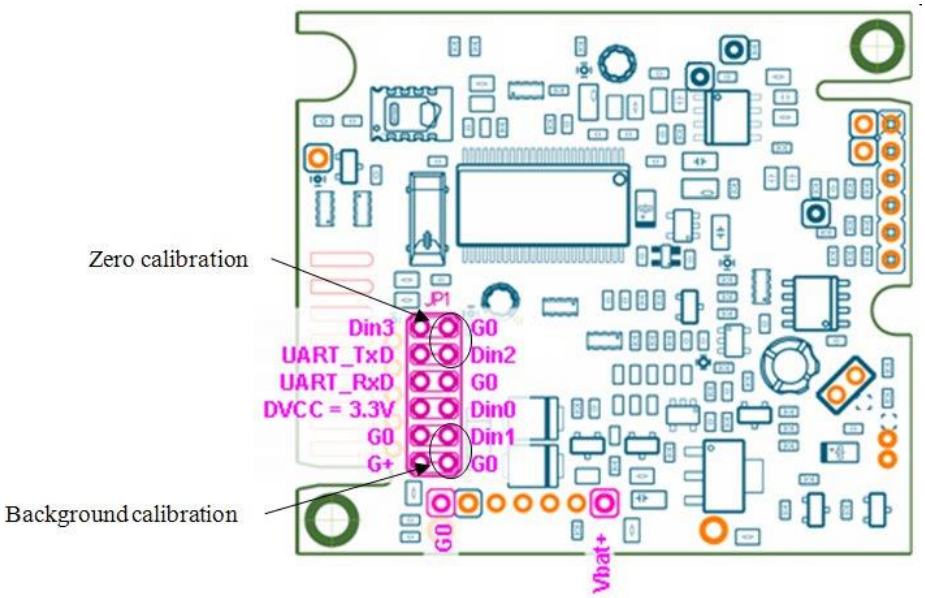


Figure 3. CO_2 Engine® K33-LP T/RH (component side) zero and background calibration inputs

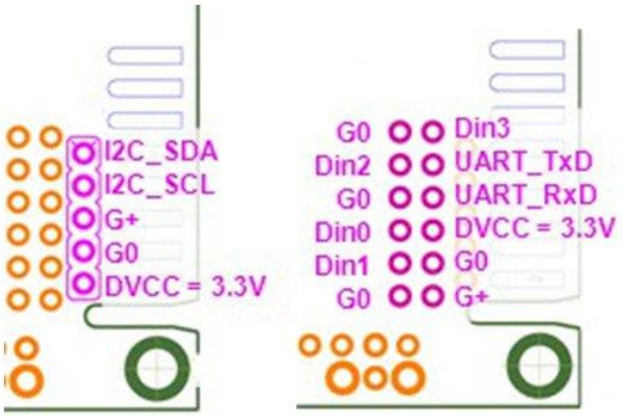


Figure 4. CO_2 Engine® K33-LP T/RH (OBA side) supply, UART and I2C connections

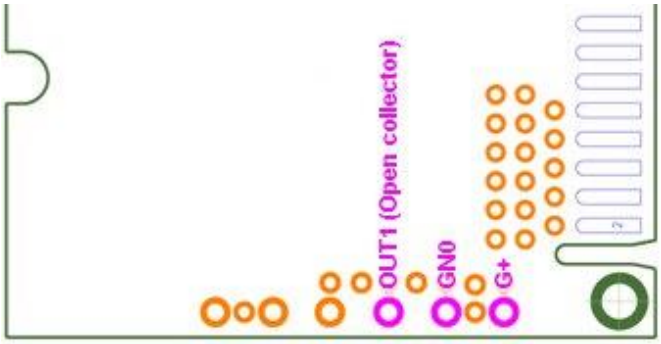


Figure 5. CO_2 Engine® K33-LP T/RH (OBA side) G+, GND and OUT1, 5.08mm pitch

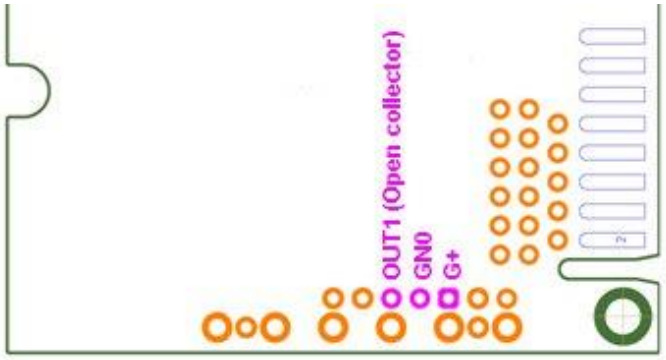


Figure 6. CO_2 Engine® K33-LP T/RH (OBA side) G+, GND and OUT1, 2.54mm pitch

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

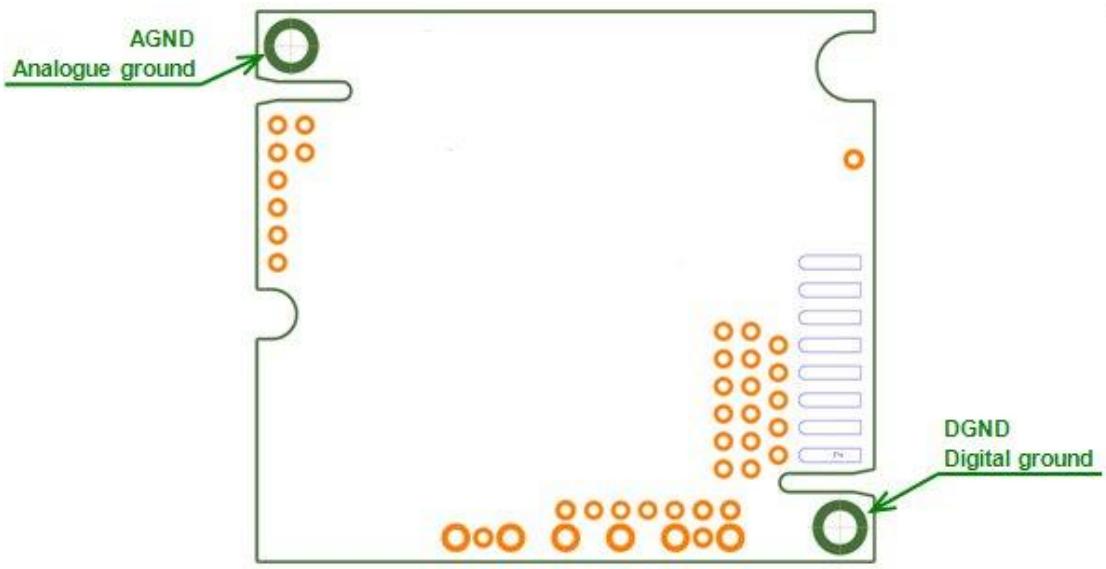


Figure 7. CO_2 Engine® K33-LP T/RH (OBA side) AGND and DGND

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 CO2.

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 CO2).

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	**bCAL** (background calibration) assuming 400 ppm CO_2 sensor exposure
Din2	**CAL** (zero calibration) assuming 0 ppm CO_2 sensor exposure

Table 3. Switch input default configurations for CO_2 Engine® K33-LP T/RH

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_2.

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_2 Engine® K33-LP T/RH* 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^2C 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	**Fatal Error**	Try to restart sensor by power OFF/ON. Contact local distributor.
1	2	**Offset regulation error**	Try to restart sensor by power OFF/ON. Contact local distributor.
2	4	**Sensirion communication error** Unable to communicate with Sensorion (temp/RH) sensor.	Try to restart sensor by power OFF/ON. Contact local distributor.
3	8	**RH error** Timeout or invalid RH value from Sensorion sensor.	Try to restart sensor by power OFF/ON. Contact local distributor.
4	16	**Detector temperature out of range** Indicates to high/low (out of range) detector temperature.	Check detailed self-diagnostic status with software tools. Contact local distributor.
5	32	**CO_2 out of range** Measured CO2 value is out of range.	Try sensor in fresh air. Perform background or zero calibration. Contact local distributor.
6	64	**Memory Error** Error during memory operations.	Try to restart sensor by power OFF/ON. Contact local distributor.
7	128	**Space temperature out of range** Measured temperature is out of range.	Try to restart sensor by power OFF/ON. 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!*

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