Product Specification

CO_2 Engine® ICB

Sensor module for bio applications

General

CO_2 Engine® ICB is targeted on bio applications with required measurement range 0 to up to 30%$_{vol}$ CO_2. This document contains description of default appearance of *CO_2 Engine® ICB*.
The sensor is built on the ***CO_2 Engine™ K33 platform.*** This platform is designed to be a low power OEM module for built-in applications in a host apparatus or/and as a stand-alone CO2 transmitter/switch module. Hence should be optimised 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. One can find extra ideas on connection and use of ***CO_2 Engine™ K33 platform*** in platform description.

CO_2 Engine® ICB has the same dimension and attachment points as K30 platform based sensors. The sensor can be supplied in diffusion modification with or without O-ring.

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Terminal description

The table below specifies terminals and I/O options available in the general **K33** platform *(see also the alternative connection pictures above)*.

Functional group	**Descriptions and ratings**
Power supply (all connection alternatives)	
G+ referred to G0	Power supply plus terminal Protected by series 3.3R resistor and zener diode Absolute maximum ratings 5 to 14V, stabilised to within 10%
G0	Power supply minus terminal Sensor's reference (ground) terminal
DVCC = 3.3V	Output from sensor's digital voltage regulator. Series resistance 10R 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.
Communication	
UART (UART_TxD, UART_RxD)	CMOS physical layer, Modbus communication protocol. (refer "Modbus on CO_2 Engine and eSense rev2_01.doc" or later version for details). 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 3.3VDVCC) min. Output low level is 0.75V max UART_RxD input is pulled up to DVCC = 3.3V by 56kOhm UART_TxD output is pulled up to DVCC = 3.3V by 56kOhm ABSOLUTE MAX RATING G0-0.5V ….. DVCC + 0.5V
I2C extension. (I2C_SCL, I2C_SDA)	Pull-up to DVCC = 3.3V. (refer "I2C comm guide rev2_00 DRAFT.pdf" or later version for details) ABSOLUTE MAX RATING G0-0.5V ….. DVCC + 0.5V

Table 1. I/O notations used in this document for the K33 platform with some descriptions and ratings (continued on next page).

Please, beware of ***the red coloured texts that pinpoint important features*** *for the system integration!*

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Outputs	
OUT1, OC (Open collector)	Digital output, Open collector Series resistance 120R Max sink current 40mA May be configured as 1. Alarm indication output 2. PWM output, 10 (alt. 12 to 16) bit resolution. Period 1 .. 1000 msec 3. Pulse length proportional to measured CO2 value.
OUT2	Analog output 0..5V Buffered linear output 0..4 or 1..4VDC or 0..5V or 1..5V, depending on specified power supply and sensor configuration. R_{OUT} < 100 R_{LOAD} > 5k **Load to ground only!** Resolution 5mV
RELAY (RelayPoleNC RelayPoleCom RelayPoleNO)	RELAY It is not a standard option. Maximum switching capability 1A/50VAC/24VDC
Digital I/Os, used as Inputs in standard configuration. May be implemented as jumper field	
Din0 Din1 Din2	Digital switch inputs in standard configuration, Pull-up 56k to DVCC 3.3V. Driving it Low or connecting to G0 activates input. Pull-up resistance is decreased to 4..10k during read of input or jumper. Advantages are lower consumption most of the time the input/jumper is kept low and larger current for jumpers read in order to provide cleaning of the contact. Can be used for zero or background calibration forcing.
Din3	R/T control line for UART connection to RS485 driver.

Table 1. I/O notations used in this document for the K33 platform with some descriptions and ratings (continue, see previous page).

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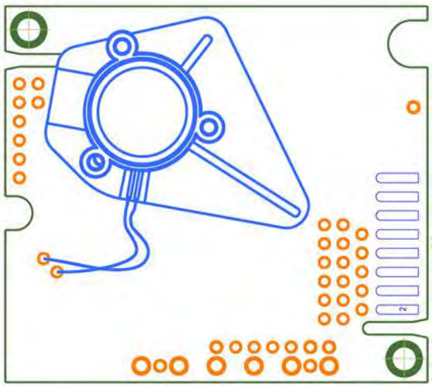

Figure 1 CO_2 Engine ICB (OBA side)

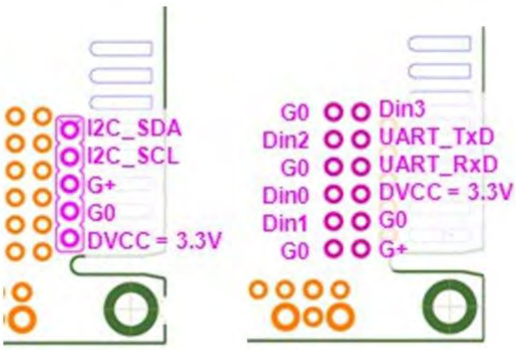

Figure 2. CO_2 Engine ICB (OBA side)

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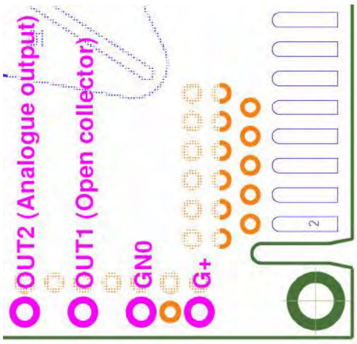

Figure 3. CO_2 Engine ICB (OBA side)
G+, GND, OUT1 and OUT2
5.08mm hole spacing

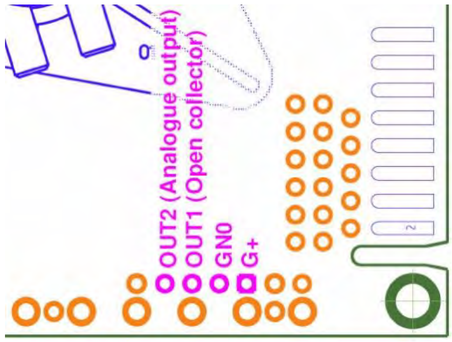

Figure 4. CO_2 Engine ICB (OBA side)
G+, GND, OUT1 and OUT2
2.54mm hole spacing

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 analogue part of the sensor and DGND is connected to the digital part of the sensor.

Do NOT connect AGND and DGND together externally to sensor!

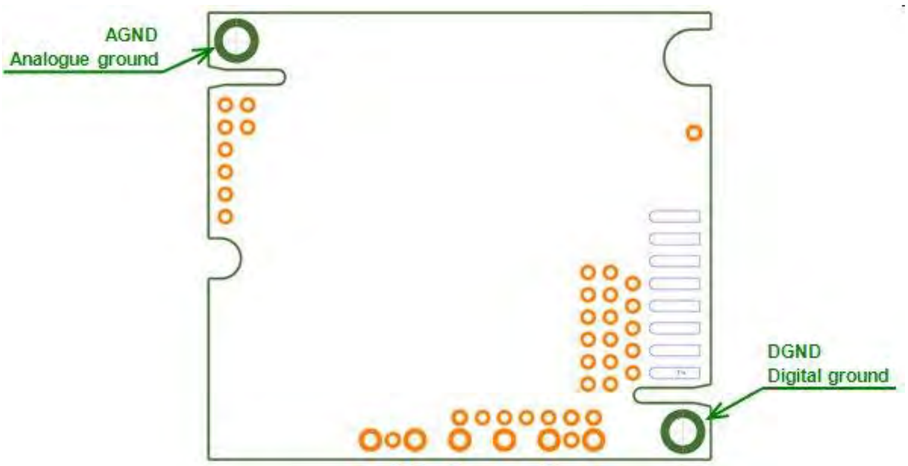

Figure 5. CO_2 Engine® ICB ground / shield attachment

Maintenance

When used in environments where the built-in self-correcting ***ABC* algorithm** can be enabled the *CO_2 Engine® ICB* is basically maintenance free. Since the ABC algorithm can not be used in all applications it is disabled in sensors default appearance.
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 with enabled ABC algorithm (at least three (3) ABC periods after installation) or after zero/background calibration.

Calibration

When enabled the ***ABC* algorithm** *(Automatic Baseline Correction)* constantly keeps track of the lowest reading of the sensor over an ABC period (7.5 days interval) and slowly corrects for any long-term drift detected as compared to the expected fresh air value of 0.04%$_{vol}$ CO_2.

Rough handling and transportation might result in a reduction of sensor reading accuracy. If the ABC algorithm is enabled it will tune the readings back to the correct numbers. The default “tuning speed” is however limited. This limit is application specific. In case that the ABC function is disabled (default appearance) or one cannot wait for the ABC algorithm to cure any calibration offset, two switch inputs Din1 and Din2 are defined for the operator to select one out of two prepared calibration codes.

If Din1 is shorted to ground, for a minimum time of eight (8) seconds, the internal calibration code **bCAL** *(background calibration)* is executed, in which case it is assumed that the sensor is operating in a fresh air environment (400ppm CO_2).

If Din2 is shorted instead, for a minimum time of eight (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 eight (8) seconds)*
Din1	**bCAL** (background calibration) assuming 400ppm CO_2 sensor exposure
Din2	**CAL** (zero calibration) assuming 0 ppm CO_2 sensor exposure

Table 2. Switch input default configurations for CO_2 Engine® ICB

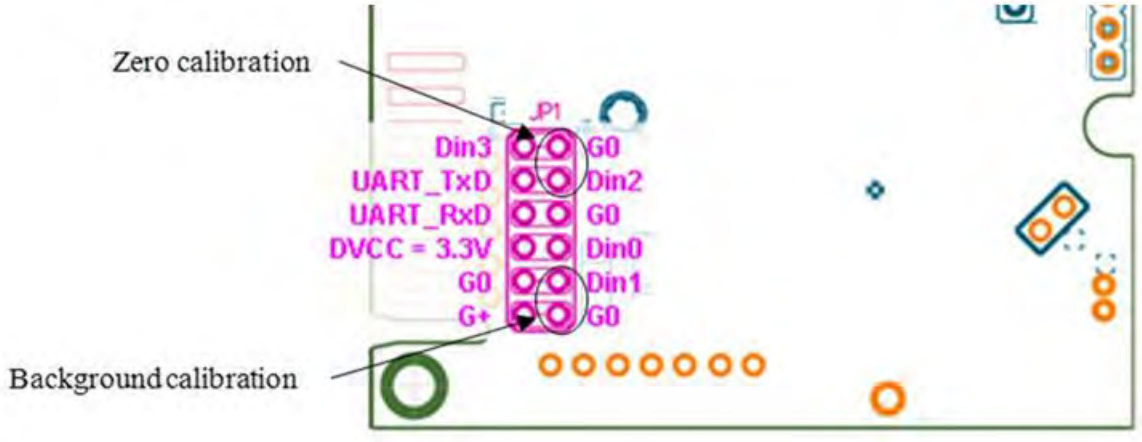

Figure 6. CO_2 Engine® ICB (component side) zero and background calibration inputs

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Technical specification (continuous operation)

Item	*CO_2 Engine ® ICB* **Art. No. 033-9-0001**
General performance	
Target Gas	Carbon dioxide (CO_2)
Storage Temperature Range	-40 to 70°C
Senson Life Expectancy	>15 years
Maintenance Interval	Maintenance-free when using SenseAir ABC algorithm (Automatic Baseline Correction).
Self-Diagnostics	Complete function check of the sensor module
Warm-up Time	1 min
Operating Temperature Range	0 to +50°C
Operating Humidity Range	Non condensing, non corrosive environment
Operating Environment	Residential, commercial, industrial spaces and potentially dusty air ducts used in HVAC (Heating Ventilation and Air-Conditioning) systems [1]
Electrical / Mechanical	
Power Input	5-14VDC max rating, stabilised to within 10% (on board protection circuits) [2]
Current Consumption	40mA average <200mA average during IR lamp ON (120msec) <250mA peak power (during IR lamp start-up, the first 50msec)
Electrical Connections [3]	terminals not mounted (G+, G0, OUT1, OUT2, Din1, Din2, TxD, RxD)
Dimensions (mm)	51 x 57 x 14 (Length x Width x approximate Height)
CO_2 measurement	
Sensing Method	non-dispersive infrared (NDIR) waveguide technology with ABC (automatic background calibration algorithm)
Sampling Method	diffusion or flow, subject for discussion with customer
Response Time (T1/e)	<20s, diffusion or tube IN/OUT (0.2l/minute gas flow)
Measurement Range	0 to 30%$_{vol}$.
Digital Resolution	0.001%$_{vol}$.
Repeatability	±0.1%$_{vol}$. CO_2 ±2% of measured value

[1] SO2 enriched environments are excluded.
[2] Notice that absolute maximum rating is 14V, so that sensor can be used with 12V±10% supply.
[3] Different options exist and can be customised depending on the application. Please contact SenseAir for further information!

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Item	*CO_2 Engine® ICB* **Art. No. 033-9-0001**
Accuracy [4, 5]	±0.5%$_{vol}$. CO_2 ±3% of measured value
Pressure Dependence	+1.6% reading per kPa deviation from normal pressure, 100kPa
On-board calibration support	Din1 switch input to trigger Background Calibration @ 400ppm (0.04%vol) CO_2 Din2 switch input to trigger Zero Calibration @ 0ppm CO_2
Linear Signal Output: [4, 6]	
OUT2	
- D/A Resolution	5mV
- Linear Conversion Range	0 – 5VDC for 0 – 20%$_{vol.}$
- Electrical Characteristics	ROUT <100, RLOAD >5k, Power input >5.5V [6]
PWM Output	
Electrical Characteristics	Open collector with series 120R resistor, 10kΩ pull-up resistor to protected power (+)
Minimum Output Concentration	0%$_{vol}$
Output Cycle Period	1004ms
Output High Level max Duration	1002ms (@20%$_{vol.}$)
Resolution	0.5ms (@0.01%$_{vol}$ = 100ppm)

Table 2. Key technical specification for CO_2 Engine® ICB

[4] In normal IAQ applications. Accuracy is defined after minimum 3 weeks of continuous operation. However, some industrial applications do require maintenance. Please, contact SenseAir for further information!

[5] 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.

[6] In normal IAQ applications. Accuracy is defined after minimum three (3) ABC periods of continuous operation. Some industrial applications do require maintenance. Please, contact SenseAir for further information!

Sensor PWM output timing diagram

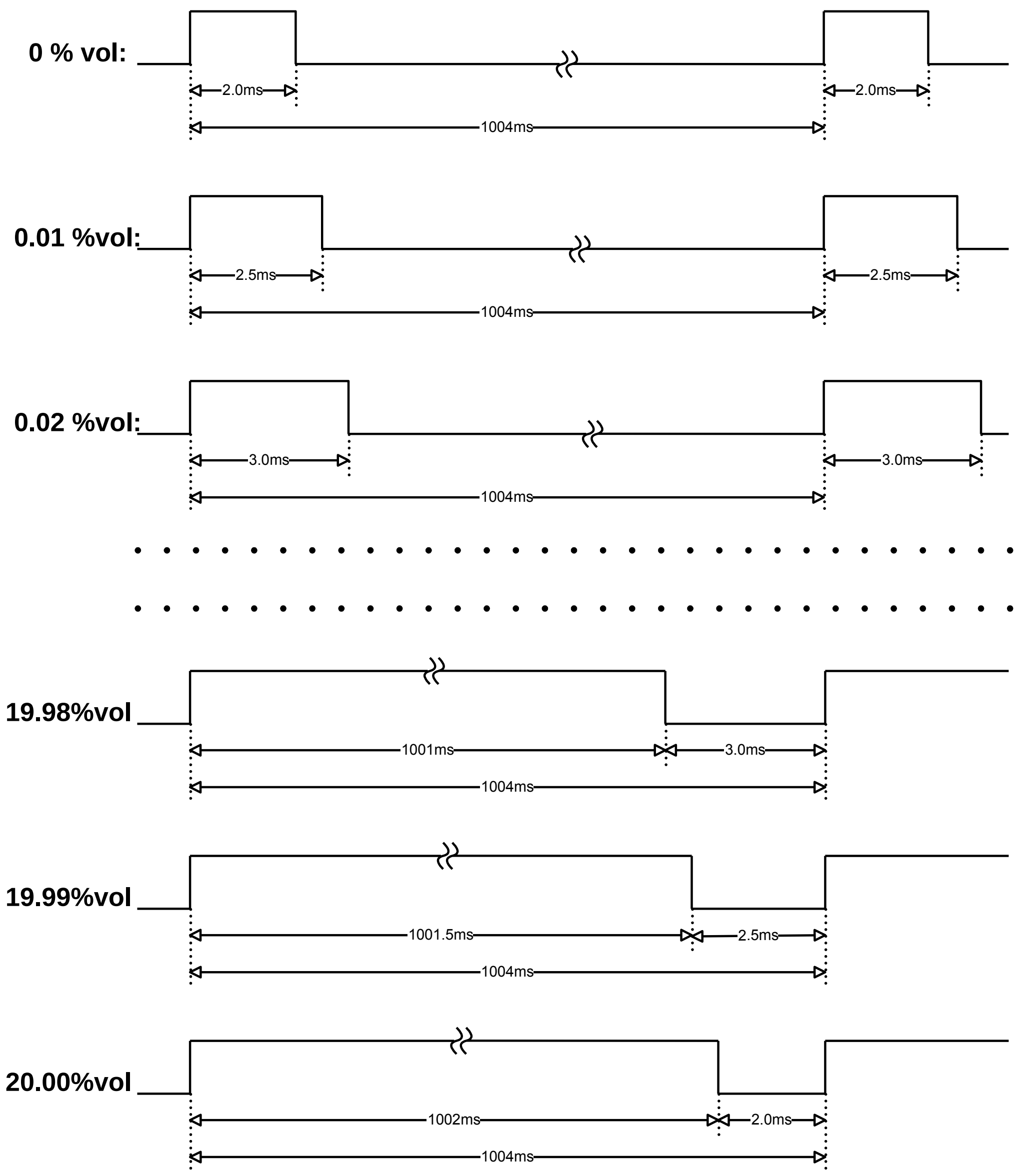

Figure 7. CO_2 Engine®ICB OUT1 timing diagram.

Gases that may affect operation of sensor

Since optical part has no reflective coating, stability of the sensor is governed by corrosion resistance of electronic assembly.

Corrosive environments containing but not limited by hydrogen sulfide, ammonia, ozone, sulphuric acid, sulfur dioxide should be avoided.

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