Datasheet: K-33 ICB Sensor

The K-33 ICB is designed to measure percentage of carbon dioxide up to 30%. It is useful for biological or scientific applications where artificially high levels of CO2 must be maintained in an enclosed apparatus.

The K-33 ICB sensor can measure CO2 in ambient air or can use the included 0.8mm tube adapter cap so that the sensor can draw gas from a remote location. One tube must have a vacuum applied (1.5 liter/min flow) while the other tube is placed directly in the airflow. Using a liquid trap filter, the sensor can be configured to take a CO2 sample from a sample containing almost 100% humidity.

With multiple input and output options, and support for I2C, RS485 and Modbus communications, the K-33 ICB combines the quality of our dual infrared NDIR sensor technology with configuration options to satisfy even the most demanding applications.

Connection to Host System Alternatives

Connection alternative A

The K-33 ICB is built in into the customer's system by connection via JP5. I2C communication is used to read measured data from the sensor. Detailed description of I2C communication with useful examples and troubleshooting can be found in our I2C comm guide.

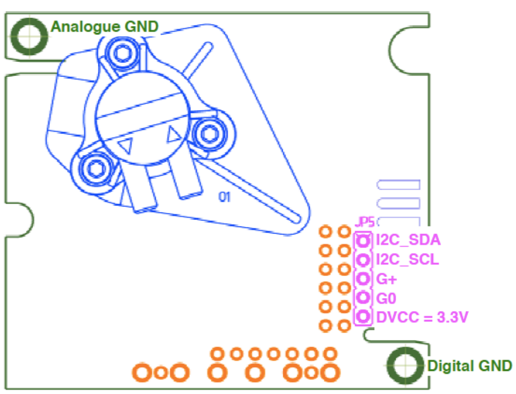

Figure 1. Possible connection terminals for reading via I2C

Note: Both Digital GND and Analog GND are connected to G0 internally.

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Connection alternative B

The K-33 ICB is built in into the customer's system by connection via JP1 or some part of it. UART with Modbus protocol communication is used to read measured data from the sensor. The K-33 ICB shares specification and Modbus register map with sensor family. Specification can be found in our Modbus documentation.

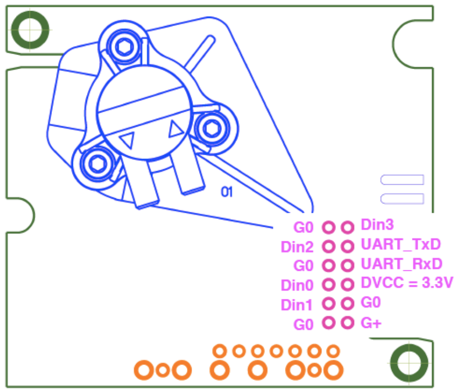

Figure 2. Possible connection terminals for reading via UART

Connection alternative C

The K-33 ICB is built in into the customer's system by connection via terminals. Signal lines on these terminals are protected and long wires may be used for connection to the host system.

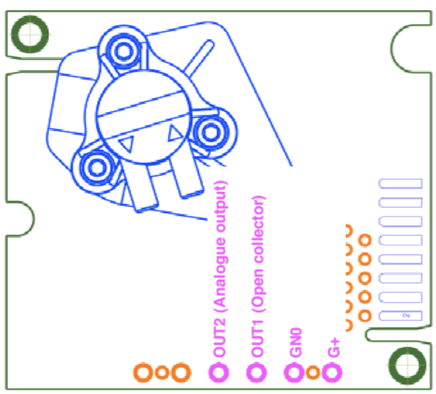

Figure 3a. 5.08mm Pitch – Possible connection terminals for connection by long wires

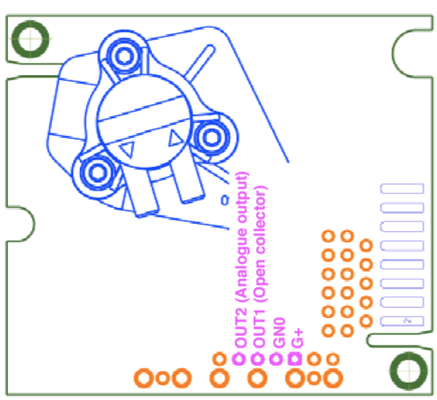

Figure 3b. 2mm Pitch – Possible connection terminals for connection by long wires

Note: OUT1, open collector is configured to provide PWM signal, see specification below.

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Connection alternative D

Combination of alternatives B and C. It's possible to use both UART and OUT1 at the same time. In the same way it's possible to use alternatives A and C, I2C and OUT1 at the same time.

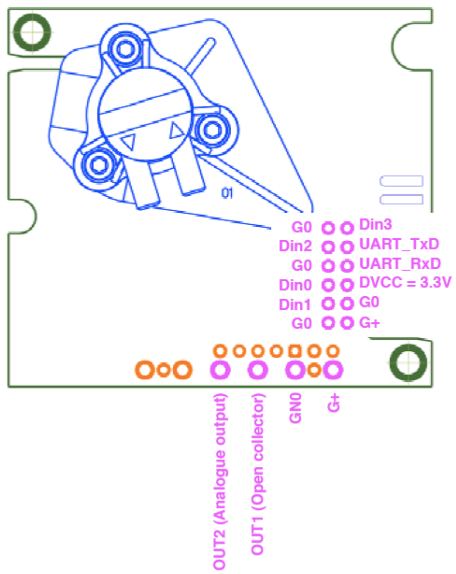

Figure 4. Possible connection terminals for connection by long wires and UART at the same time

Diffusion or Tube IN/OUT Alternatives

The K-33 ICB can be supplied in diffusion modification with or without O-ring.

Figure 5. Diffusion model

The sensor can be supplied in tube in/out modification with different orientation of tube attachment head in steps of 120 degrees.

Figure 6. Tube IN/OUT model

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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, stabilized 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 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.
Communication	
UART (UART_TxD, UART_RxD)	CMOS physical layer, ModBus communication protocol. (refer Modbus documentation 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 3.3V 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
I2C extension. (I2C_SCL, I2C_SDA)	Pull-up to DVCC = 3.3V. (refer I2c comm. guide or later version for details) ABSOLUTE MAX RATING G0-0.5V ….. DVCC + 0.5V
Outputs	
OUT1, OC (Open collector)	Digital output, Open collector Series resistance 120 R 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. ROUT < 100 W, RLOAD > 5 kW **Load to ground only!** Resolution 5mV
Digital I/Os, used as Inputs in standard configuration. May be implemented as jumper field	
Din0 Din1	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.

Din2	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. Can be used to switch output range or to force output to predefined state. All depends on customer needs, see description of default appearance below.
Din0, Din1, Din2, Din3, Din4	Digital switch inputs, pull-up 120k to DVCC 3.3V. Driving it Low or connecting to ground 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 to initiate calibration or to switch output range or to force output to predefined state. All depends on customer needs.
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. Please, beware of* ***the red colored texts that pinpoint important features*** *for the system integration!*

Mechanical Drawings

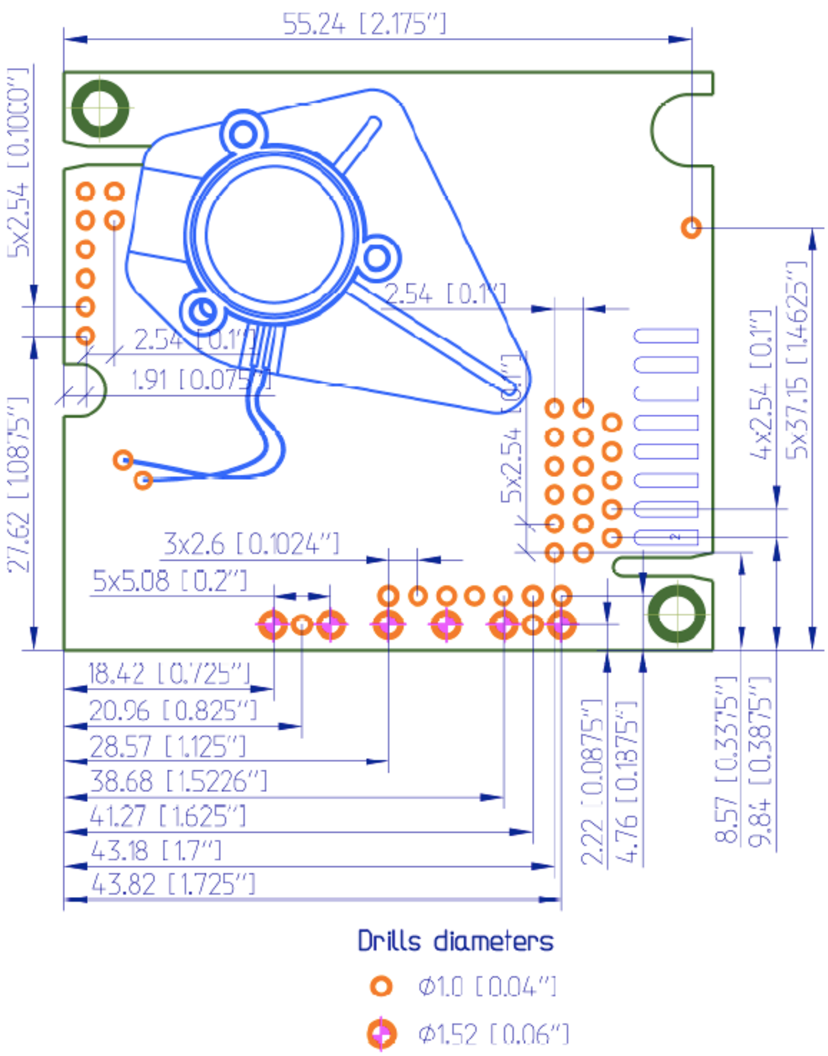

Figure 7. Hole/contacts positions.

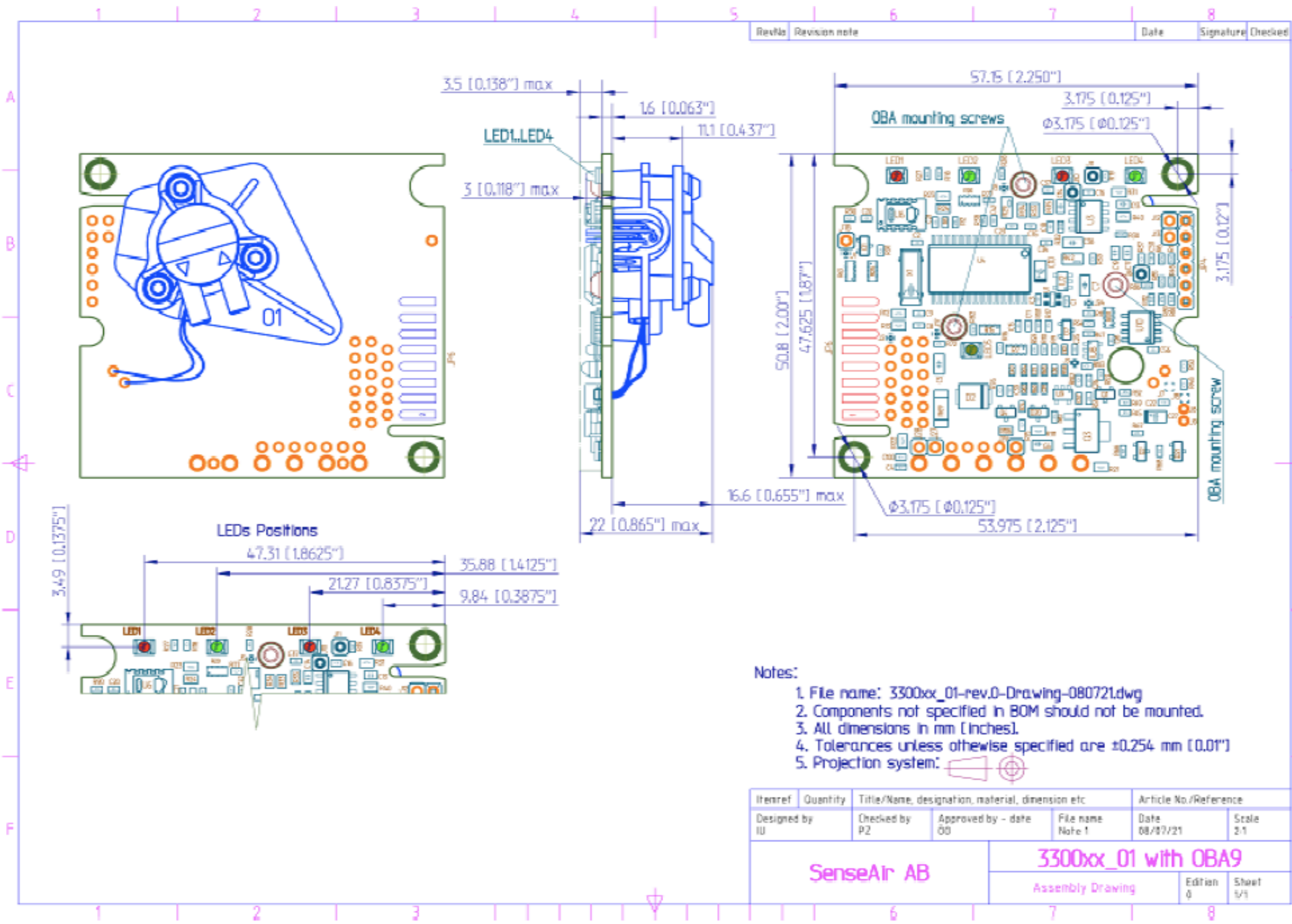

Figure 8. Tube IN/OUT model

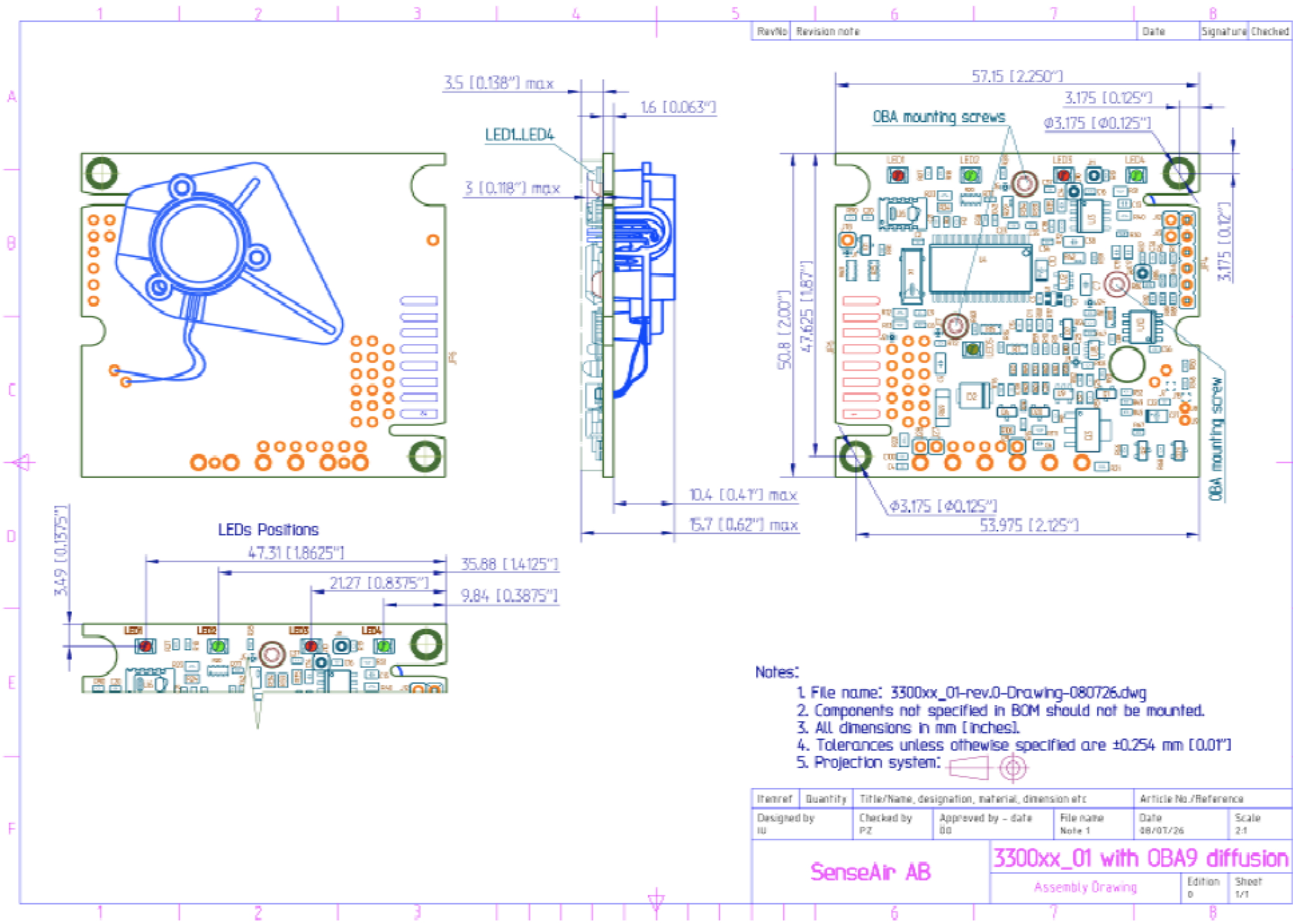

Figure 9. Diffusion model

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!

Maintenance

The K-33 ICB 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 (at least 3 weeks after installation)!

Calibration

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 0.04%vol CO2.

ABC algorithm may be adapted for particular application. For example, sensor may be forced to sample data used for ABC only during first few hours after powering up when container is open and CO2 concentration is about 400 ppm.

Another possibility comes if end user is going to pump fresh air through the sensor some time. Then it can force calibration by shorting corresponding digital input.

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 however limited. This limit is application specific. For post calibration convenience, in the event that 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 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 (400 ppm CO2). If Din2 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 CO2 (i.e. Nitrogen or Soda Lime CO2 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)
Din1	**bCAL** (background calibration) assuming 400 ppm CO2 sensor exposure
Din2	**CAL** (zero calibration) assuming 0 ppm CO2 sensor exposure

Table 2. Switch input default configurations for K-33 ICB

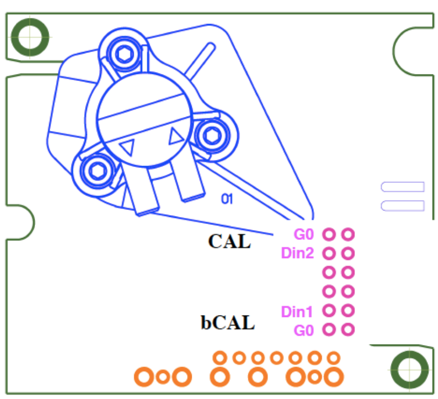

Figure 10. Calibration jumpers

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Technical Specifications

General Performance

Storage Temperature Range .... -40 to +70 °C
Sensor Life Expectancy .... > 15 years
Maintenance Interval .... Maintenance-free if ABC (Auto Baseline Correction) algorithm is applicable.
Self-Diagnostics .... complete function check of the sensor module
Warm-up Time .... ≤ 1 min
Conformance with the standards................. Emission: EN61000-6-3:2007
Immunity: EN61000-6-1:2007
RoHS directive 2002/95/EG
Operating Temperature Range .... -10 to 50 °C
Operating Humidity Range .... 0 to 95% RH (non-condensing)
Operating Environment .... Residential, commercial, industrial spaces and Potentially dusty air ducts used in HVAC (Heating Ventilation and Air-Conditioning) systems.

CO2 Measurement

Measurement Range ....0 – 30%
Sensing Method .... non-dispersive infrared (NDIR) waveguide technology with ABC automatic background calibration algorithm
Sampling Method ....diffusion or flow
Repeatability .... ± 0.1 %vol. CO2 ± 2 % of measured value (TBD, may be improved after tests)
Accuracy .... ± 0,2 %vol. CO2 ± 3 % of measured value
Sensitivity .... ± 20 ppm ± 1 % of measured value
Pressure Dependence.................................. + 1.6 % reading per kPa deviation from normal pressure, 100 kPa
On-board calibration support .... Din1 switch input to trigger Background Calibration @ 400 ppm (0.04%) CO2
Din2 switch input to trigger Zero Calibration @ 0 ppm CO2

Electrical/Mechanical

Power Input... 5-14 VDC max rating, stabilized to within 10% (on board protection circuits)
Current Consumption .... 40 mA average
< 150 mA peak current (averaged during IR lamp ON, 120 msec)
< 300 mA peak power (during IR lamp start-up, the first 50 msec)
Dimensions .... 5.1 x 5.7 x 1.4 cm (Length x Width x approximate Height)

Linear Signal Outputs

OUT2 D/A Resolution .... 5 mV
Linear Conversion Range ...... 0 - 5 VDC for 0 – 30%$_{vol}$.
Electrical Characteristics .... R_{OUT} < 100 Ω, R_{LOAD} > 5 kΩ , Power input > 5.5 V

PWM Output

Electrical Characteristics .... Open collector with series 120R resistor, 10kW pull-up resistor to protected power (+)
Minimum output concentration 0%vol
Output cycle period 1004ms
Output high level min duration ....2.0ms (@ 0%vol)
Output high level max duration .... 1002ms (@ 20%vol.)
Resolution .... 0.5ms (@0.01%vol = 100 ppm)

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Sensor PWM output timing diagram

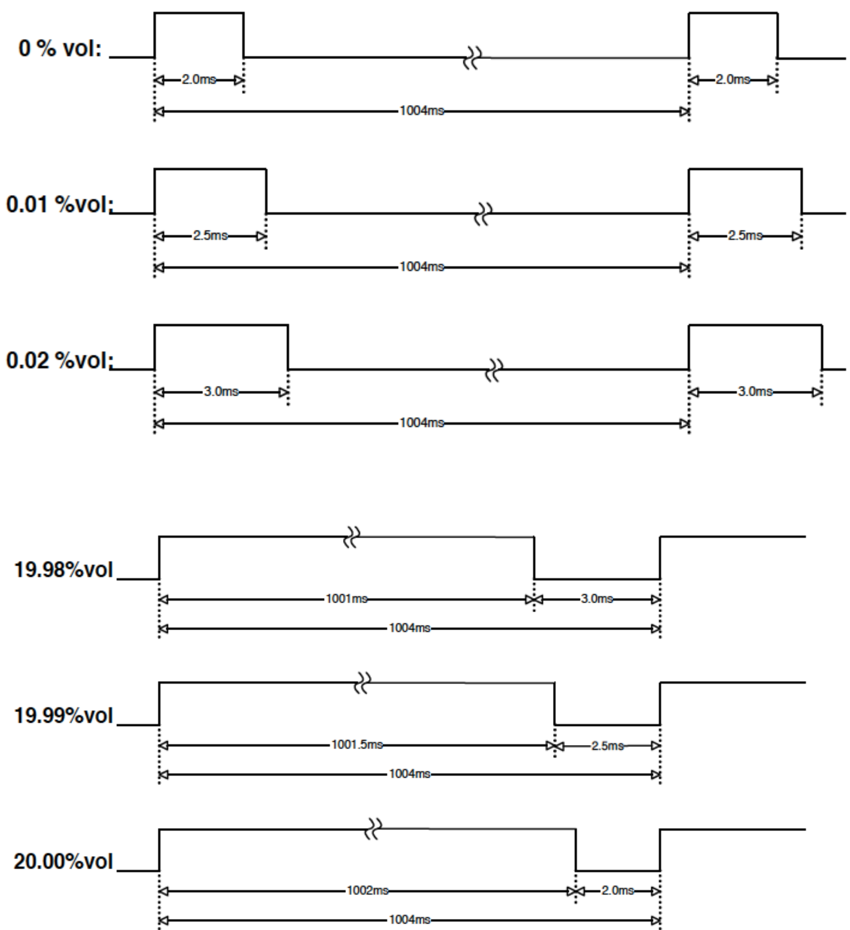


Figure 15. OUT1 timing diagram.

Gases that may affect sensor's operation

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

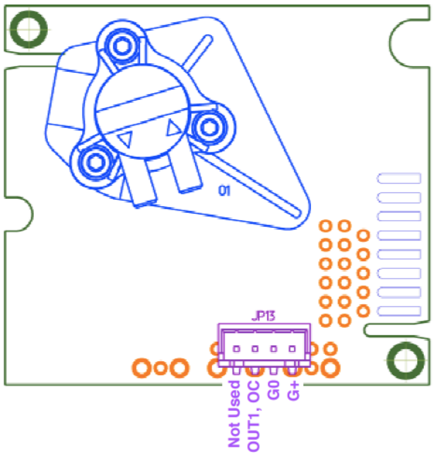
Corrosive environments containing but not limited by hydrogen sulfide, ammonia, ozone, sulphuric acid, sulfur dioxide should be avoided.

Use Ideas (connections)

Alternative E

The K-33 ICB is a stand-alone module connected to the host system by 3-wire interface (JP13 may be chosen to be 3 pole connector) with power supply and open collector output for alarm condition indication. Open collector output may drive LED or relay or buzzer in the case of alarm conditions.

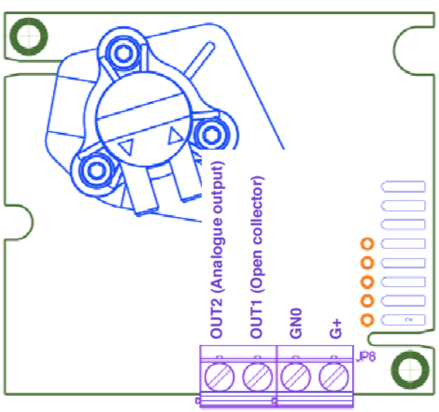
Open collector may provide PWM signal with duty cycle representing CO2 concentration



Alternative F

The sensor is a stand-alone module connected to the host system by 3-wire interface (JP8 may be chosen to be 3 pole terminal) with power supply and open collector output for alarm condition indication. Open collector output may drive LED or relay or buzzer in the case of alarm conditions.

Open collector may provide PWM signal with duty cycle representing CO2 concentration



Alternative G

The sensor is a stand-alone module with open collector output and NC/NO relay

Open collector may provide PWM signal with duty cycle representing CO2 concentration