Manual
K-30 3% & 10% CO2
Sensor Module and OEM Platform

General
The **K30** sensor platform *CO$_2$ Engine $^\circledR$ K30 3%* can be customised for a variety of sensing and control applications. This platform is designed to be an OEM module for built-in applications in a host apparatus, and 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.

Item	CO_2 Engine® K30 3% Art. No. 030-7-0001
Target gas	Carbon dioxide (CO_2)
Operating Principle	Non-dispersive infrared (NDIR)
Measurement range	0 to 3%$_{vol}$ (extended range up to 10%$_{vol}$)
Accuracy	±300ppm ±3% of reading[1]
Response time ($T_{1/e}$)	20sec diffusion time
Rate of Measurement	0.5Hz
Operating temperature	0 to 50°C
Operating humidity	0 to 95%RH non condensing
Storage temperature	-30 to 70°C
Dimensions	51 x 57 x 14 mm (Length x Width x approximate Height)
Power supply	4.5 to 14.0VDC maximum rating (without reverse polarity protection) stabilised to ±5% over load and line changes. Ripple voltage less than 100mV.[2]
Current Consumption	40mA average <150mA peak current (averaged during IR lamp ON, 120msec) <300mA peak power (during IR lamp start-up, the first 50msec)
Warm Up time to spec	1 min
Life expectancy	>15 years
Serial communication	UART, Modbus protocol. Direction control pin for direct connection to RS485 receiver integrated circuit.
OUT 1	D/A Resolution: 10mV (10 bit) Linear Conversion Range: 1 to 4V = 0 to 2% Electrical Characteristics: R_{OUT} <100 Ω, R_{LOAD} >5kΩ
OUT 2	D/A Resolution: 5mV (10 bit) Linear Conversion Range: 1 to 4V = 0 to 2% Electrical Characteristics: R_{OUT} <100Ω, R_{LOAD} >5kΩ
OUT 3	-
OUT 4	-
Maintenance	Maintenance-free with using SenseAir ABC logic Self calibration using for normal indoor applications

Table 1. Key technical specification for the CO_2 Engine® K30 3%

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[1] Accuracy is specified over operating temperature range at normal pressure 101.3kPa. Specification is referenced to certified calibration mixtures. Uncertainty of calibration gas mixtures (±1% currently) is to be added to the specified accuracy for absolute measurements.

[2] Notice that absolute maximum rating is 14V, so that sensor can be used with a 12V±10% supply.

Terminal descriptions

The table below specifies what terminals and I/O options are available in the general **K30** platform. Please note, however, that in the *CO$_2$ Engine ® K30 3%* default configuration, only OUT1, OUT2, Din1, Din2 and Status have any pre-programmed functions. These are described in the chapter *"Default Configuration"*.

Functional group	Descriptions and ratings
Power supply	
G+ referred to G0:	Absolute maximum ratings 4.5 to 14V, stabilised to within 5% 5.0 to 9V preferred operating range. **Unprotected against reverse connection!**
Outputs	
OUT1	Buffered linear output 0..5 or 1..5VDC or 0..10V or 2..10V, depending on specified power supply and sensor configuration. **Load to ground only**! Resolution: 10mV (8.5 bits in the range 1..5V). Can be used as an overview alternative to OUT2, or in an independent linear control loop, such as housing temperature stabilisation.
OUT2	Buffered linear output 0..5 or 1..5VDC, depending on specified power supply and sensor configuration. **Load to ground only!** Resolution: 5mV (10 bits)
OUT3	CMOS **unprotected**. Digital (High/Low) output. High Output level in the range 2.3V min to DVDD = 3.3V. (1mA source) Low output level 0.75V max (4mA sink) Can be used for gas alarm indication, or for status indication etc.
OUT4	CMOS **unprotected.** Digital (High/Low) output. High Output level in the range 2.3V min to DVDD = 3.3V. (1mA source) Low output level 0.75V max (4mA sink) Can be used for gas alarm indication, or for status indication etc.
Status	CMOS **unprotected.** High Output level in the range 2.3V min to DVDD = 3.3V. (1mA source) Low output level 0.75V max (4mA sink)
Serial Communication	
UART (TxD, RxD)	CMOS, ModBus communication protocol. Logical levels corresponds 3.3V powered logics. Refer *"ModBus on CO2 Engine K30"* for electrical specification.
I^{2}C extension.	
Contact SenseAir	Pull-up of SDA and SCL lines to 3.3V.
Inputs & Optional jumper field	
Din0, Din1, Din2, Din3, Din4	Digital switch inputs have pull-up 120kΩ to DVCC 3.3V most of the time. Pull-up resistance is decreased to 4..10kΩ only during read of input / jumper to provide cleaning of the contacts by larger currents. They are the same as inputs on IDC connector. Can be used to initiate calibration or to switch output range or to force output to predefined state. All depends on customer needs.

*Table 2. I/O notations used in this document for the K30 platform with some descriptions and ratings. Please, beware of **the red coloured texts that pinpoint important features** for the system integration!*

Installation

The modules are factory calibrated and ready for use directly after power up. There are several alternative ways to connect the *CO_2 Engine® K30 3%* to a host system:

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

1.   Using "UART connector", including terminals for power supply (G+ and G0), UART (TxD, RxD).

2.   Using the 3 pins **main terminal**. Available signals are power supply (G+ and G0) and the buffered analogue output (OUT1). A variety of user selections exists for this option regarding standard 5.08 mm pitch components and mounting alternatives (top/bottom).

3.   Using 20 pin connector strips, or **IDC connector**, most of the system information is reached.

Host integration considerations and EMI shielding

If an IDC connector is being used to connect the K30 module to a host PCB, this connector can in some situations be used as the only fixture. If instead fixing the K30 PCB using mechanical poles and screws, no more than two (2) positions should be considered. This is because the PCB should not be exposed to any mechanical stress, and it is small and lightweight enough for just 2 attachment points.

To provide means for attachments, there are four (4) possible screw holes available, all of them having a collar that is electrically connected to ground (G0). These connections are, however, not totally equivalent:

*   The two screw points in the upper left corner (having the IDC and edge connectors faced downwards, are connected to the *analogue* ground. They are the preferred choice for connection to some EMI shield, if so is required. This is normally necessary only if the application is such that large EMFs are foreseen. If this option is being used, precaution must be taken so as to exclude any power supply currents! Sensor reading instability is an indication of the need for shielding, or of improper enclosure system groundings.

*   The two screw points in the right bottom corner are connected to the *digital* ground. Connection to some EMI housing shield is less effective when this option is used, but on the other hand the sensor may be powered via these connections.

Note 1: To avoid ground loops, one should avoid connecting the analogue and digital grounds externally! They are connected internally on the K30 PCB.

Note 2: 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 *CO_2 Engine® K30 3%* configuration is a simple analogue output sensor transmitter signal directed to OUT1 and OUT2. Output OUT1 is configured to give a measurement overview, whereas OUT2 by default is to provide more exact measurements. Via the edge connector serial communication terminal, the CO_2 readings are available to an even higher precision (Modbus protocol), 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	1.0…4.0VDC	0…2%CO_2
OUT2	1.0…4.0VDC	0…2%CO_2

Table 3. Default analogue output configuration for CO_2 Engine® K30 3%

Background- / Zero Calibration procedure

The sensor has two calibration functions: zCal that will adjust the sensor to show 0ppm, and bCal that will adjust the sensor to 400ppm. The reference gas used should contain a CO_2 concentration of 0 or 400ppm. If the reference gas has a concentration that differs from 0 or 400ppm, we recommend to calibrate using UIP5 instead of the method described below.
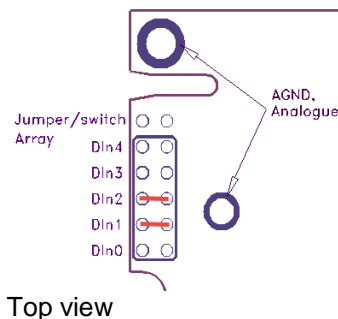
1. Connect sensor with tube and nipple (two alternative positions for nipple attachment).
   - Soft Tube: 2x4mm
   - Nipple: nylon hose, 30x0.8x2.2mm
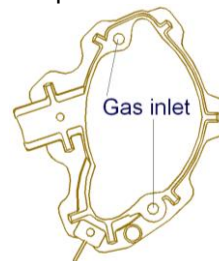
2. Let gas mixture flow into the sensor through applied tube.
   - **bCal:** 400ppm CO_2 **zCal:** 0ppm, e.g. Nitrogen
   - Flow time: ≥3 minutes
   - Flow range: 0.3─1.0 litre/minute

3. Short circuit **Din1** (bCal)/**Din2** (zCal)
   - Shortcut Time: ≥8 seconds

Top view

4. Calibration executed?

Yes	No
(Sensor shows 400ppm (bCal)/0ppm (zCal) CO_2)	(sensor detected unstable gas concentration) 1. wait 10 seconds 2. repeat step 3 and 4

5. Remove shortcut (do not breathe on sensor)!

Input Switch Terminal (normally open)	Default function (when closed for minimum 8 seconds)
Din1	**bCAL** (background calibration) assuming 400ppm CO_2 sensor exposure
Din2	**zCAL** (zero calibration) assuming 0ppm CO_2 sensor exposure

Table 4. Switch input default configurations for K30 3% ext. range 10%

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 lowest reading of 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.

When checking the sensor accuracy, <u>PLEASE NOTE</u> that the sensor accuracy is defined at continuous operation (at least three (3) ABC periods after installation with ABC turned ON)!

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 200ppm/week.

Maintenance

The **CO$_2$ Engine**®**K30** 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 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 logic output terminal **Status** would be put into Low level state. 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.

Output Terminal	Default function
Status	High level = OK Low level = Fault

Table 5. Default Logic output configured for CO$_2$ Engine ® K30 3%

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	**Algorithm Error**. Indicate wrong EEPROM configuration.	Try to restart sensor by power OFF/ON. Check detailed settings and configuration with software tools. Contact local distributor.
3	8	**Output Error** Detected errors during output signals calculation and generation.	Check connections and loads of outputs. Check detailed status of outputs with software tools.
4	16	**Self-Diagnostic Error**. 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** Accompanies most of other errors. Can also indicate overload or failures of sensors and inputs. Resets automatically after source of error disappearance.	Check connections of temperature and relative humidity probe (if mounted). Try sensor in fresh air. Perform CO_2 background calibration. Check detailed status of measurements with software tools. *See Note 1!*
6	64	**Memory Error** Error during memory operations.	Check detailed settings and configuration with software tools.
7	128	**Reserved**	

Table 6. Error code and action plan

Note 1. *Any probe is out of range. 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. Could also indicate the need of zero point calibration. If the CO_2 readings are normal, and still the error code remains, any other sensor probe mounted (if any) can be defect, or the connection to this probe is 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!*

Support
The quickest way to obtain technical support is via email. Please send all support inquires to support@co2meter.com.

Please include a clear, concise definition of the problem and any relevant troubleshooting information or steps taken so far, so we can duplicate the problem and quickly respond to your inquiry.

Warranty
This meter comes with a 1YEAR (warranty period) limited manufacturer's warranty, starting from the date the meter was shipped to the buyer.

During this period of time, CO2Meter.com warrants our products to be free from defects in materials and workmanship when used for their intended purpose and agrees to fix or replace (at our discretion) any part or product that fails under normal use. To take advantage of this warranty, the product must be returned to CO2Meter.com at your expense. If, after examination, we determine the product is defective, we will repair or replace it at no additional cost to you. This warranty does not cover any products that have been subjected to misuse, neglect, accident, modifications or repairs by you or by a third party. No employee or reseller of CO2Meter.com's products may alter this warranty verbally or in writing.

Use of this device in environments above 95% humidity may cause irreparable damage to the components and is not warranted.

Liability
All liability under this agreement shall be limited to the actual cost of the product paid to CO2Meter.com. In no event shall CO2Meter.com be liable for any incidental or consequential damages, lost profits, loss of time, lost sales or loss or damage to data, injury to person or personal property or any other indirect damages as the result of use of our products.

Returns
If the product fails under normal use during the warranty period, a RMA (Return Material Authorization) number must be obtained from CO2Meter.com. After the item is received CO2Meter.com will repair or replace the item at our discretion.

To obtain a RMA number, call us at or email us at (386) 256-4910 support@co2meter.com. When requesting a RMA please provide reason for return and original order number.
If the product fails under normal use in the first 10 days of ownership, at our discretion we will email you a postage-paid UPS label to return the product at our expense.

If we determine that the product failed because of improper use (water damage, dropping, tampering, electrical damage etc.), or if it is beyond the warranty date, we will inform you of the cost to fix or replace the product.

Contact Us
We are here to help!
For information or technical support, please contact us.
 support@CO2Meter.com
        (386) 256-4910 (Technical Support)
        (386) 872-7665 (Sales)
 www.CO2Meter.com

Address:
CO2Meter, Inc.
131 Business Center Drive
Ormond Beach, FL 32174
USA