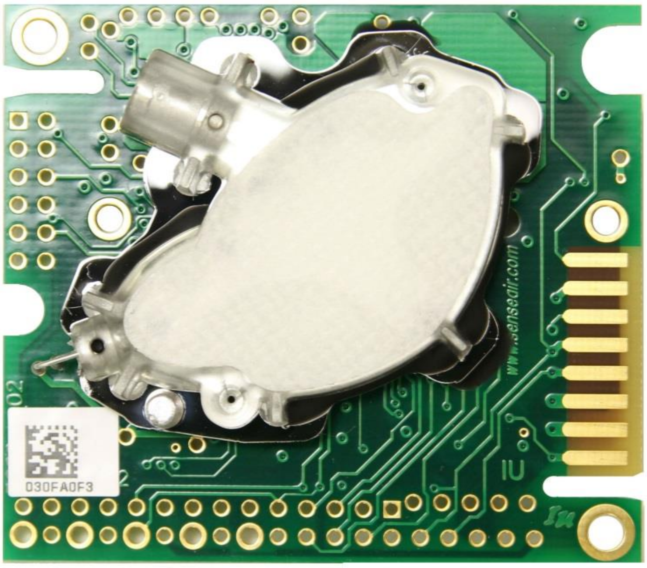
Product Specification

CO_2 Engine® K30 STA

Sensor Module and OEM Platform



General

The **K30** sensor platform *CO_2 Engine ® K30 STA* can be customized 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 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 ® K30 STA* Art. no. 030-8-0006
Target gas	Carbon dioxide (CO_2)
Operating Principle	Non-dispersive infrared (NDIR)
Measurement range	0 to 5000 ppm_{vol}
Accuracy	±30 ppm ±3% of reading[1]
Response time ($T_{1/e}$)	20 sec diffusion time
Rate of Measurement	0.5 Hz
Operating temperature	0 to +50 °C
Operating humidity	0 to 95% RH non condensed
Storage temperature	-30 to +70 °C
Dimensions (mm)	51 x 57 x 14 mm (Length x Width x approximate Height)
Power supply	4.5 to 14.0 VDC maximum rating (without reverse polarity protection) stabilized to +-5% over load and line changes. Ripple voltage less than 100mV.[2]
Warm Up time to spec precision	1 min
Life expectancy	>15 years
Compliance with	RoHS directive 2011/65/EU Tested according; Immunity: EN 61000-6-3:2007, Emission: EN 61000-6-2:2007
Serial communication	UART, Modbus protocol. Direction control pin for direct connection to RS485 receiver integrated circuit.
OUT 1	D/A Resolution: 10 mV (10 bit) Linear Conversion Range: 0 to 4 V = 0 to 2000 ppm Electrical Characteristics: R_{OUT} < 100 Ω, R_{LOAD} > 5 kΩ
OUT 2	D/A Resolution: 5 mV (10 bit) Linear Conversion Range: 1 to 5V = 0 to 2000 ppm Electrical Characteristics: R_{OUT} < 100 Ω, R_{LOAD} > 5 kΩ
OUT 3	Digital (High/Low) output, 700/800 ppm
OUT 4	Digital (High/Low) output, 900/1000 ppm
Maintenance	Maintenance-free when using SenseAir ABC algorithm *(Automatic Baseline Correction)*.

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

* PATENTED: WO 97/18460, WO 98/09152, WO 2005/015175

[1] 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.

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

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Terminal descriptions

The table below specifies what terminals and I/O options are available in the general **K30** platform *(see also the layout picture Fig. 2)*. Please note, however, that in the *CO_2 Engine® K30 STA* 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, stabilized 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 stabilization.
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. (1 mA source) Low output level 0.75V max (4 mA 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. (1 mA source) Low output level 0.75V max (4 mA 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. (1 mA source) Low output level 0.75V max (4 mA 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^2C 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 120k 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. 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 colored texts that pinpoint important features*** *for the system integration!*

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General PCB overview

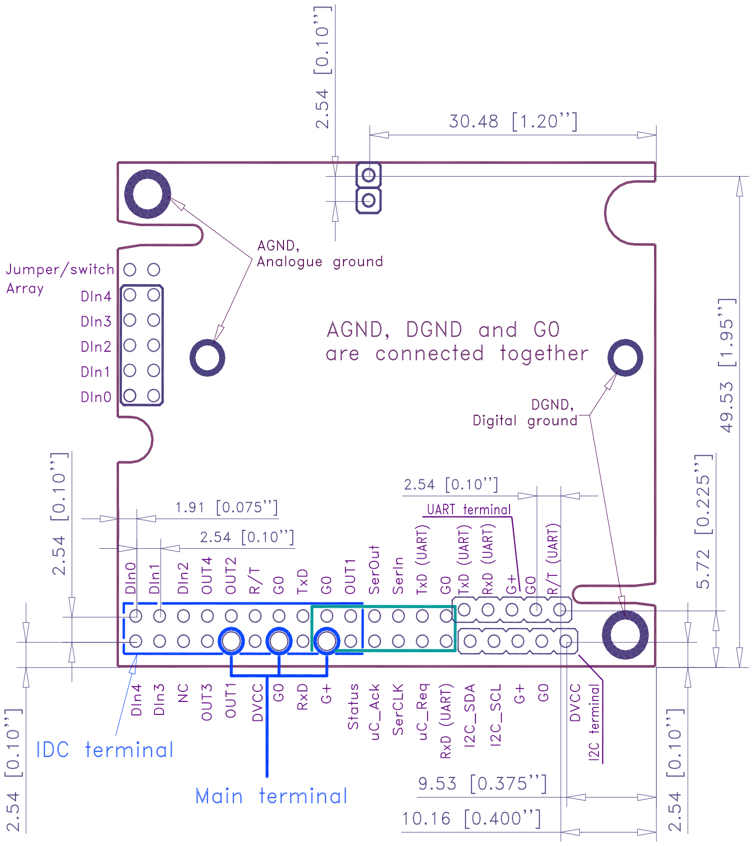

Figure 1. CO_2 Engine®K30 STA I/O notations, terminal positions and some important dimensions for mounting the K30 platform PCB into a host system (Top view).

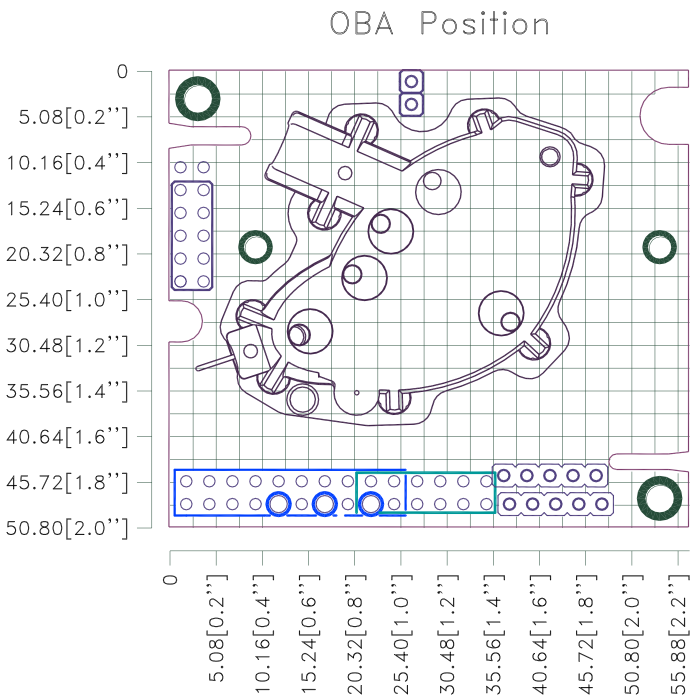

Figure 2.. CO_2 Engine®K30 STA OBA position.

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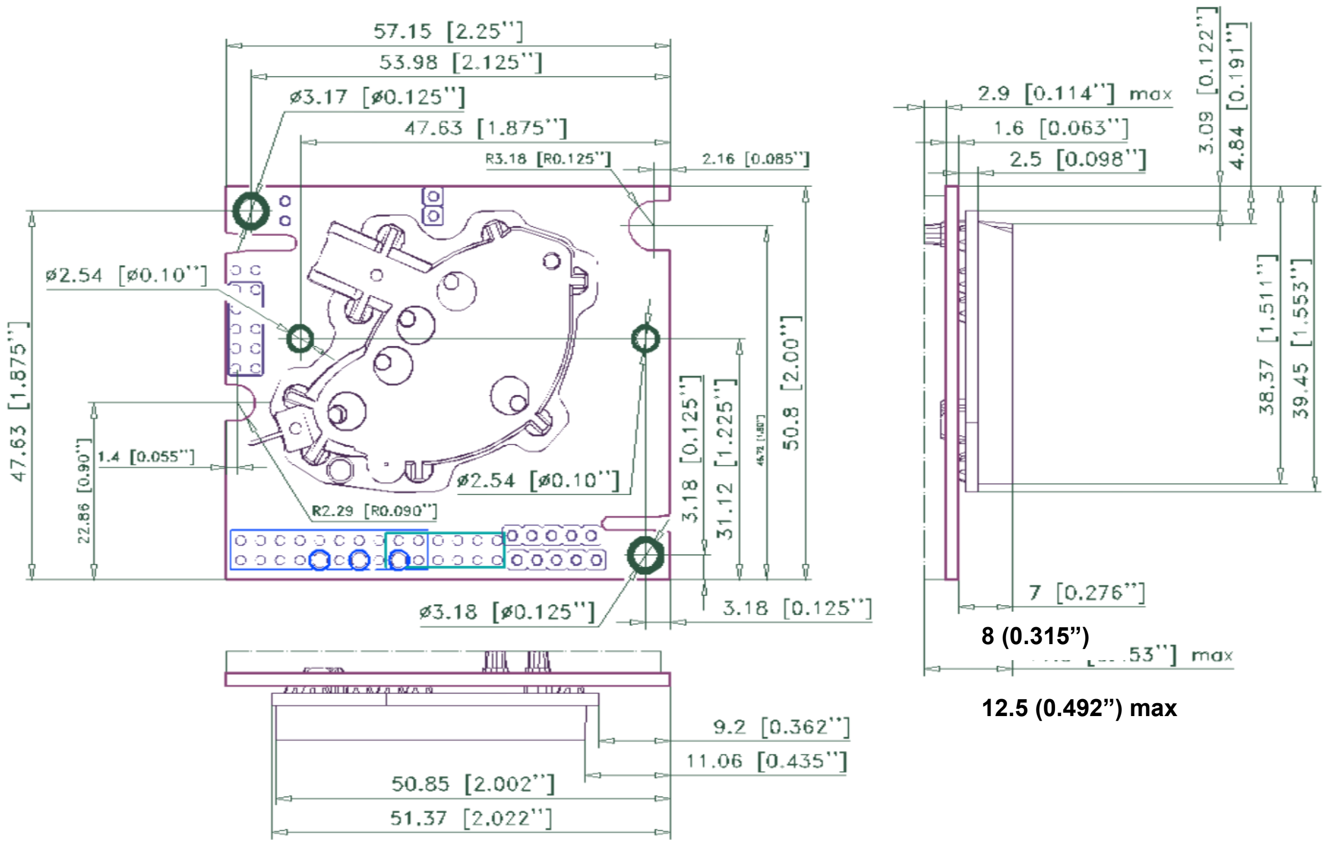

Figure 3. CO_2 Engine® K30 STA mechanical drawing

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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 STA* to a host system (see also figure 2):

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 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 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, as in Figure 2) 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.

Under no circumstances should any force be applied to the OBA, this may permanently harm the sensor and most definitely affect performance. Sensor should be handled holding PCB only.

Never touch sensor with bare hands, make sure that operators use ESD gloves.

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.

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Default functions /configurations

Outputs

The basic CO_2 *Engine® K30 STA* 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	0.0…4.0 VDC	0…2000 ppm CO_2
OUT2	1.0…5.0 VDC	0…2000 ppm CO_2

Table 3: Default analogue output configuration for CO_2 Engine®K30

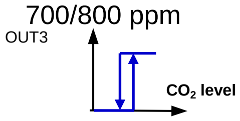
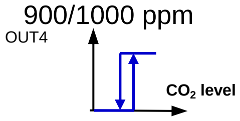
Terminals	Output	Correspondence
OUT3	Logical levels: Low <0.75V High>2.3V and <3.3V	700/800 ppm 
OUT4	Logical levels: Low <0.75V High>2.3V and <3.3V	900/1000 ppm 

Table 4. Default digital output configuration for CO_2 Engine® K30 STA

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Calibration

Single-point 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. This number can be selected to any other value of preference using serial interface and PC software provided by SenseAir.

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 the two holes labeled Din1 actuates the calibration process. A closure here will ground one of the micro-controller I/O pins. 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_2).

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 8 seconds)*
Din1	**bCAL** (background calibration) assuming 400 ppm CO_2 sensor exposure
Din2	**CAL** (zero calibration) assuming 0 ppm CO_2 sensor exposure

Table 5. Switch input default configurations for CO_2 Engine® K30 STA

Note: *To make a full sensor recalibration, including also a change of the sensor span constant, a serial communication interface is required. Contact SenseAir for technical support on this matter if this is required.*

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 30 ppm/week.

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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 6. Default Logic output configured for CO_2 Engine® K30 STA

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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 7. 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!*

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