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Datasheet: K-30 Sensor

The K30 sensor is a low cost, infrared and maintenance-free transmitter module intended to be built into different host devices that require CO2 monitoring data.

Applications

The K30 is an accurate, yet low cost gas sensing solution for OEMs who wish to integrate CO2 gas sensing into their product without investing in their own gas sensor development. The compact sized and low powered module is intended to be an add-on component to compliment other microprocessor-based controls and equipment.

The K30 may be software customized in different ways in order to optimize the total system with respect to the OEM application.

The K30 is offered for installation in OEM IAQ sensor housings, OEM air handling units, OEM alarm sensor housings, among other applications. The only restriction for what this product can be used for is the creativity and inventiveness of the customer.

This new product version is a RoHS compliant upgrade replacing the former the K30 product, has the same key product performance, but now has an improved speed of response and a reduced spatial build-in height.

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 K30-STA default configuration, only OUT1, OUT2, OUT3, OUT4, 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 5.5 to 14V, stabilized to within 10% 5V to 9V preferred operating range. **Unprotected against reverse connection!**
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.
Outputs	
OUT1	Buffered linear output 0..4 or 1..4VDC or 0..10V or 2..10V, depending on specified power supply and sensor configuration. ROUT < 100 W, RLOAD > 5 kW **Load to ground only!** Resolution 10mV (8.5 bits in the range 0..4V).
OUT2	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 Can be used as alternative for OUT1, or for a second data channel, or in an independent linear control loop, such as a housing temperature stabilization
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)

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	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
	DVDD Regulated Voltage Output 3.3V to 50mA
Inputs	
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.
I2C extension.	
See our I2C Comm. guide	Pull-up of SDA and SCL lines to 3.3V

***Table 1**. 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!*

General PCB Overview

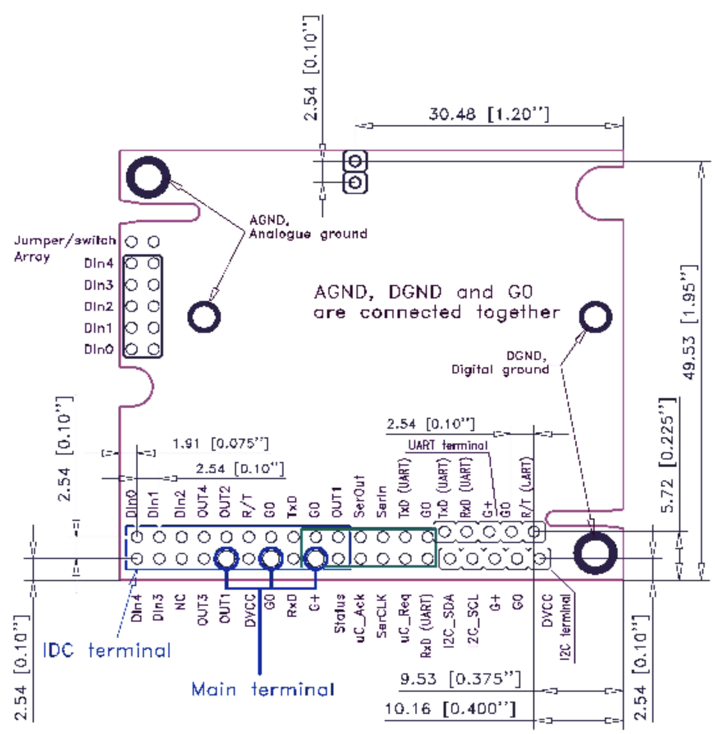

Figure 2. K30 I/O notations, terminal positions and some important dimensions for mounting the K30 platform PCB into a host system (Top view). The blue filled pins are defined by default.

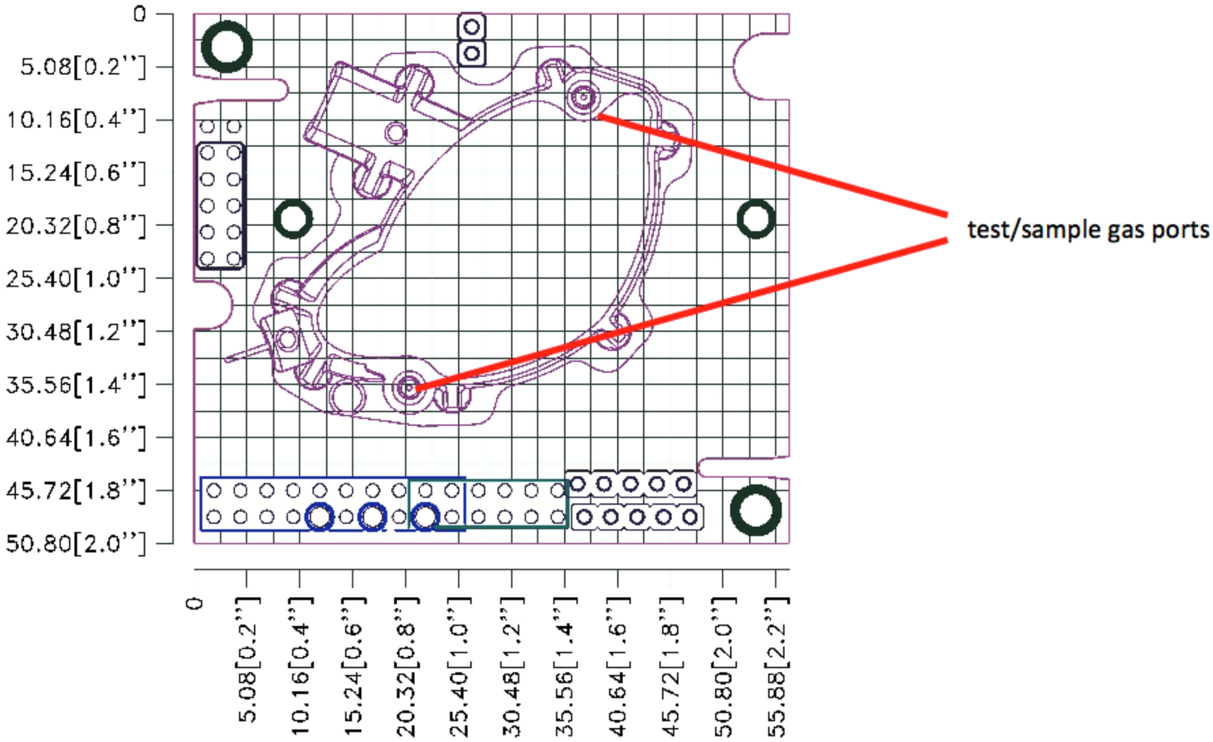

Figure 3. K30 OBA position.

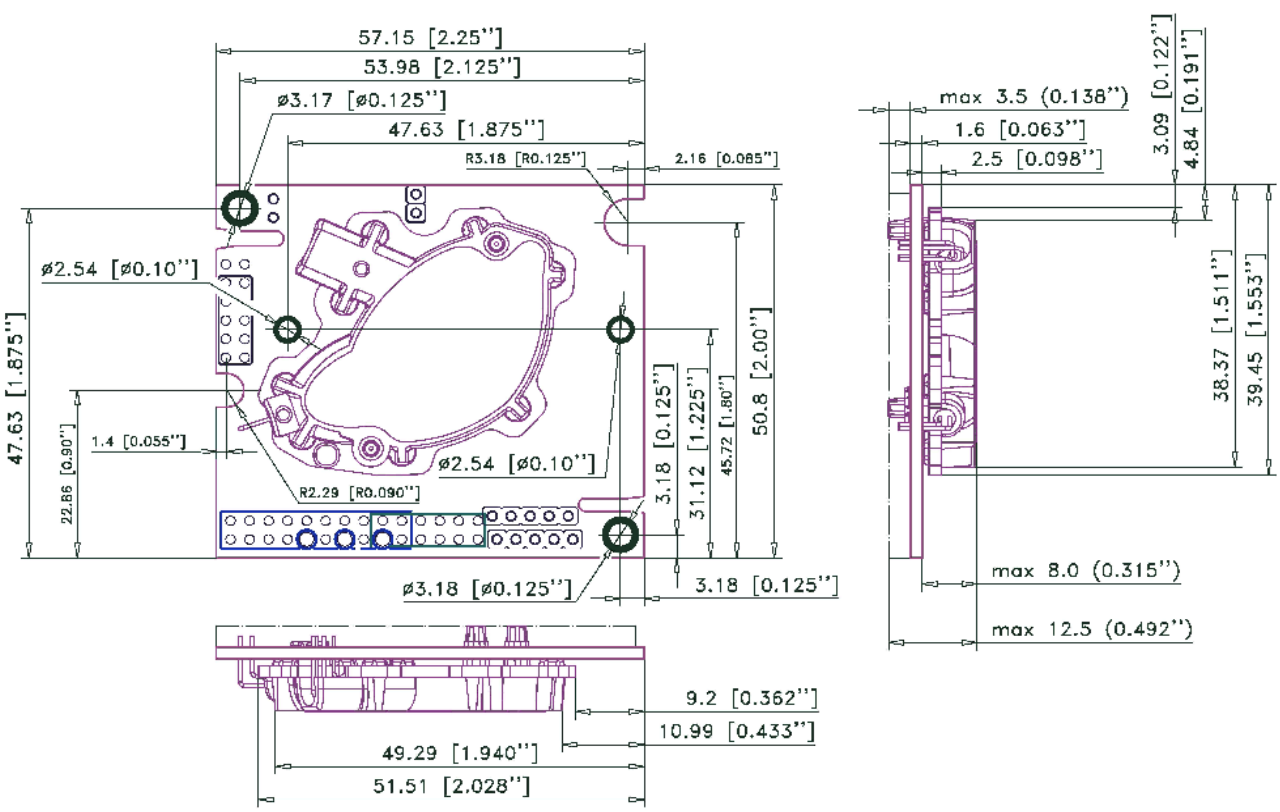

Figure 4. K30 mechanical drawing.

Installation

The modules are factory calibrated and ready for use directly after power up. There are several alternative ways to connect the K30 to a host system (see also Figure 2):

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 exist 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.

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 / Configuration

Outputs

The basic K30-STA configuration is a simple analogue output sensor transmitter signal directed to OUT1 and OUT2. Via the edge connector serial communication terminal, the CO2 readings are available to an even higher precision (Modbus protocol), together with additional system information such as sensor status, analogue outputs, and other variables.

Terminals	Output	Correspondence
OUT1	0,0…4,0 VDC	0…2,000 ppm CO2
OUT2	1,0…5,0 VDC	0…2,000 ppm CO2

Table 2. Default analogue output configuration for K30-STA

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The basic K30-STA configuration provides digital outputs to indicate if CO2 concentration exceeds alarm threshold.

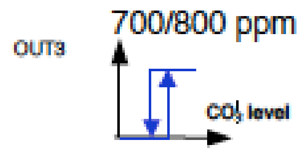
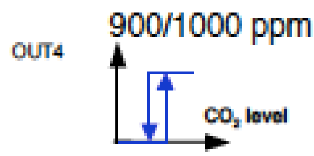
Terminals	Output	Correspondence
OUT3	Logical levels: Low < 0.75V High = 5V	
OUT4	Logical levels: Low < 0.75V High = 5V	

Table 3. Default digital output configuration for K30-STA

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 400 ppm CO2.

Defaults

- K30 Sensors – ABC on by default
- K30 SDKs – ABC off by default
- For applications where the sensor will never read 400ppm (fresh) air, the K30 should be ordered with ABC disabled.

Manual Calibration

Rough handling and transportation may reduce sensor reading accuracy. With time, the ABC function will tune the readings back to the correct numbers. The default "tuning speed" is however limited to about 30 ppm/week. For post calibration convenience, in the event that one cannot wait for the ABC algorithm to cure any calibration offset, or if ABC is disabled, two switch inputs - Din1 and Din2 - select of two prepared calibration codes. If Din1 is shorted to ground for a minimum 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 for a minimum of 8 seconds, the alternative operation code CAL (zero calibration) is executed in which case the sensor is assumed to be in a gas mixture free from CO2 (i.e. Nitrogen or Soda Lime CO2 scrubbed air).

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 3. Switch input default configurations for K30

Manual Calibration Procedure

The 0ppm CO2 calibration procedure is as follows. For fresh air, skip steps 1-2.

1. Connect the sensor on top with a tube (soft tubing 2x4 mm) and a nipple (nylon tubing 30x0.8x2.2 mm), see Figure 4 below. There are 2 alternative positions for nipple attachment.
2. Let a gas mixture flow into the sensor through the applied tube. The flow shall be in the range of 0.3 – 1.0 liter/minute during 3 minutes. Keep the gas mixture flowing during the whole procedure.
3. Short circuit the Din2 (Din1 for fresh air) for a minimum of 8 seconds.
4. Verify the zero calibration. The meter will show 0 ppm CO2 (400ppm for fresh air).
5. If zero calibration is not executed (sensor detects unstable gas concentration) wait 10 sec and repeat steps 3 and 4 again.

Human breath contains 300,000ppm CO2. Do not breath anywhere near the sensor, or the fresh air will be contaminated!

Figure 4. K30 with connected tube

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 will be put into Low level state. The full error codes are available from the UART port or via I2C 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 K30

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Error Codes and Action Plan

Error codes 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 CO2 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**	

Note 1. *Any probe is out of range. Occurs, for instance, during over-exposure of CO2 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 CO2 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!*

Maintenance

The K30 is basically maintenance free in normal environments if the ABC algorithm is active. When checking the sensor accuracy, note that the sensor accuracy is defined as after 3 weeks of continuous operation.

General Performance

Storage Temperature Range	-30 to +70 °C
Sensor Life Expectancy	> 15 years
Maintenance Interval	no maintenance required
Self-Diagnostics	complete function check of the sensor module
Warm-up Time	≤ 1 min
Conformance with the standards................	Emission: EN61000-6-3:2001 Immunity: EN61000-6-2:2001 RoHS directive 2002/95/EG
Operating Temperature Range	0 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 – 5,000 ppm $_{vol.,}$ within specifications 0 – 10,000 ppm $_{vol.}$ total CO2 detection range
Sensing Method	non-dispersive infrared (NDIR) waveguide technology with ABC automatic background calibration algorithm
Sampling Method	Diffusion
Response Time ($T_{1/e}$)	20 sec diffusion time
Response Rate	2 sec
Sensitivity	± 20 ppm ± 1 % of measured value within specifications
Accuracy	± 30 ppm ± 3 % of measured value within specifications
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 CO2 Din2 switch input to trigger Zero Calibration @ 0 ppm CO2

Electrical/Mechanical

Power Input...	5-14 VDC, stabilized to within 10%
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)
Electrical Connections	Terminals not mounted (G+, G0, OUT1, OUT2, Din1, Din2, Status, TxD, RxD)

Linear Signal Outputs

D/A Conversion Accuracy............................		± 2 % of reading ± 20 mV
OUT1	D/A Resolution	10 mV
	Linear Conversion Range	0 - 4 VDC for 0 - 2 000 ppm $_{vol.,}$
	Electrical Characteristics	ROUT < 100 W, RLOAD > 5 kW , Power input > 4.5 V
OUT1	D/A Resolution	5 mV
	Linear Conversion Range	0 - 5 VDC for 0 - 2 000 ppm $_{vol.,}$
	Electrical Characteristics	ROUT < 100 W, RLOAD > 5 kW , Power input > 5.5 V

Digital Outputs

Electrical Characteristics	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). Protection 56R resistor in series.
Function	High level at *CO_2 High*
OUT3, CO_2 High Alarm /Reset Level ...	800/700 ppm
OUT4, CO_2 High Alarm /Reset Level ...	1000/900 ppm

UART Serial COM Port

Protocol	MODBUS open protocol, refer specification and registers definitions
Hardware interface	CMOS UART with RxD, TxD and R/T
Baud Rate	9600

Warranty

90 days