ALTERED CARBON

PRECISON GRAPHENE SENSORS

Environmental monitoring with ultra low power and cost graphene gas sensors.

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K9SENSE-NO_2

NITROGEN DIOXIDE GAS SENSOR

Altered carbon have created a new type of gas sensor by harnessing the power of the groundbreaking nano-material graphene.

The K9Sense-NO_2 also has the ability to target ammonia with low cross sensitivity, this resilient new type of sensor is only the beginning for developments in robotics, IoT, the SMART world and the future...

Key Features	Applications	Key Benefits
High Sensitivity (ppb)	Environmental Monitoring	Mass Sensing
Very Low Power Operation	Diesel Pollution	Realtime Monitoring
Pre-calibrated To Zero	Waste Management	Passive Operation
Low Profile Form Factor	Chemical Industry	Ultra Low-power
Fast Sensor Response (<3s)	Medical Diagnostics	Solid State
Solid STate	Indoor Pollution	5 Year Life Span

K9D Sensor Range

The K9Sense range offers ultra low-power sensors for a variety of different gases. Our "Wake On Sense" technology allows for real-time gas monitoring while consuming around 1µw of power. The K9DSense sensor range is designed for power critical applications such as IoT (Internet Of Things) and real-time monitoring.

Concentration Range	5 ppb - 100 ppm
Response Time	<3 seconds
Digital Interface	I2C, Interrupt Pin

PASSIVE LOW POWER OPERATION

Our unique graphene technology allows for sensor operation without a heating element, ensuring true passive operation. This allows the K9Sense range to operate with just a few µA of power.

The sensor is easily driven with minimal analog circuitry, to ensure very low power consumption even when taking measurements from the sensor.

We offer a reference design using the ICE40 FPGA, to allow low power operation even when running machine learning based analysis.

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K9 Sense Evaluation Kit
Engineering sample

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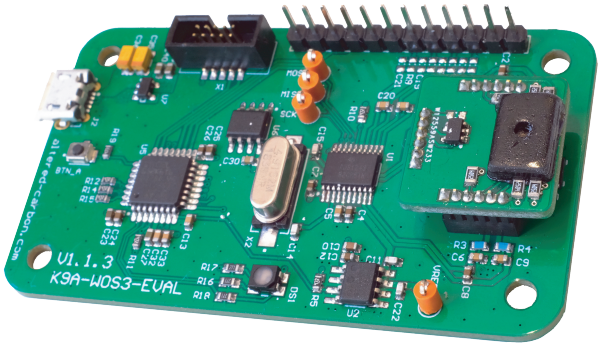
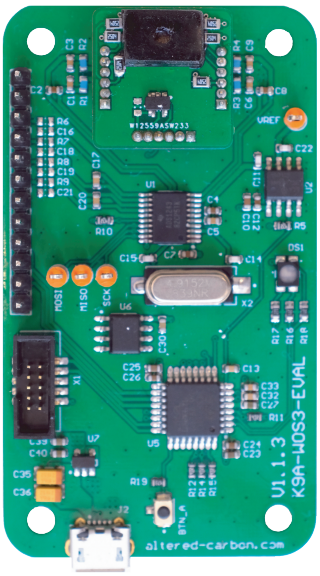
K9 Sense

Beta Evaluation Kit





General Information

Works with 5V supply

Low power : 200µA in passive sense mode outputs
- Temperature
- Relative Humidity
- Gas Concentration

Simple Virtual Com Port Interface

Operating temperature: 0oC - 50oC

RoHS compliant

Small Form Factor (8 x 5.6 x 3 mm)

Lightweight (<0.2 g)

Components Used

INA317µA instrumentation amplifier

AD5272BRMZ-100 Nano power ADC chip

STM32 Cortex M0 processor

Content Includes

Analog gas sensor development board.

Two samples of Altered Carbon K9 sensors

Micro USB to USB

Link to setup and logging utility

Link to full design documentation
- Schematic
- Parts list (BOM)
- Gerber/design files
- Firmware

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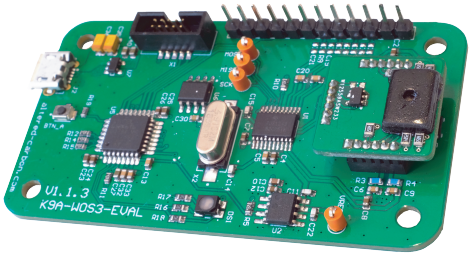

Applications

- Air pollution monitoring
- Indoor air quality
- Breath analysis
- Exhaust gas monitoring
- Gas alert system

Benefits

- Low Power – 200 µA at 1Hz polling
- FastResponse – 1ms typical
- FastRecovery – < 2mins
- Calibrated & temp compensated output
- Simple virtual com port interface
- Integrated T & RH monitoring
- Small form-factor
- Lightweight sensor (< 0.2 g)
- I2C Interface

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ANALOG GAS SENSOR DEVELOPMENT BOARD

Description

K9 Sensors are making it easy for the Internet of Things developers to integrate gas sensing in their products. Gas alert systems, air pollution monitoring, indoor air quality, breath analysis are some of the known gas sensing applications that demand high-performance measurement. A solid-state nano-tech chemiresistor gas sensing transducer is the preferred solution for these applications due to measurement performance and the ultra-low power consumption needed for battery operation.

MEASUREMENT PERFORMANCE CHARACTERISTICS

Gas Sensor	Measurement Range (ppb)	Resolution (1) (ppb)
Nitrogen dioxide (NOx/NO2)	20 - 1000	0.5

Note (1) - Based on the standard deviation of noise at 200 ppb, 0.1 Hz measurement 60 second average.

Based on Standard Conditions 25 °C, 50% RH and 1 atm.	
Measurement Repeatability	<±1% of reading
Recommended Warm-Up Time	10 seconds from power applied to USB port
Power Consumption	200 µA at 1Hz polling 9 mA in active mode (typically on for < 1 sec) 14 mA when reading from USB in real-time
Expected Operating Life	>1 years (3 years @ 25 ± 10°C; 60 ± 30% RH)
Operating Temperature Range	0°C to 50°C
Operating Humidity Range	15 to 95% (0 to 100% non-condensing intermittent)
Mechanical Dimensions of Sensor	8 x 5.6 x 3 mm
Mechanical Dimensions of Sensor Carrier Board	17.15 x 17.15 x 11.40 mm
Mechanical Dimensions of Development Board	66 x 30 x 8 mm
Weight	< 0.2 g

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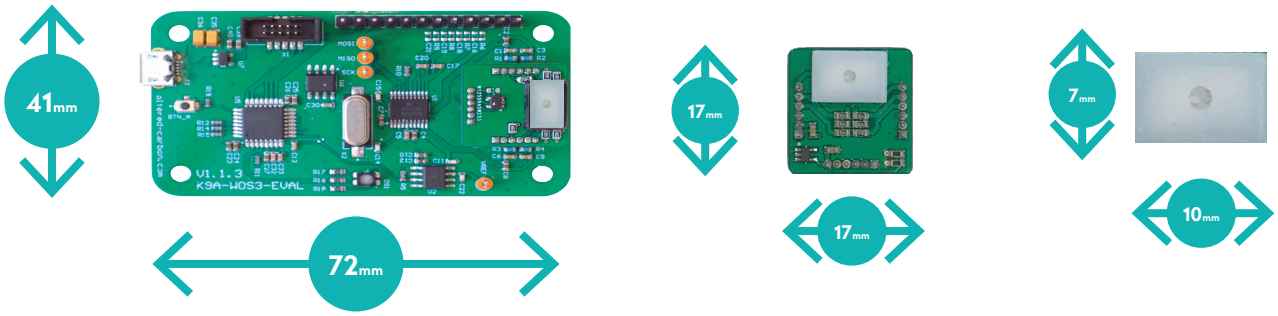
ABSOLUTE MAXIMUM RATINGS

Parameter	Conditions	Min	Rec	Max	Units
Maximum Concentration	Short term exposure		1000	10000	ppb
Supply Voltage	Regulated	4.5	5.0	5.5	V
Storage Temperature	Vapor sealed @ 50% RH	10		40	^{0}C
Storage Humidity	Non-condensing, vapour sealed	20		80	% RH
Storage Pressure	Vapour sealed		1		atm
Storage Time	Vapour sealed		24		months
Operating Temperature	Continuous	0	25	50	^{0}C
Operating Humidity	Continuous, non-condensing	15		95	% RH
Operating Pressure	Continuous		1		atm
ESD Rating	Human Body Model	2		8	kV

ELECTRICAL CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Supply Current	Passive sensing mode	0.2	0.2	14	mA
Power Consumption	Passive sensing mode	1	1	70	mW

PACKAGE OUTLINE DRAWING & DIMENSIONS



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Bridge board PINOUT

Pin#	Function	Notes
A	EXEC1+	Bridge 1 Excitation Plus
B	B1+	Bridge 1 plus
C	B1-	Bridge 1 minus
D	GND	Ground
E	NC	Not connected
F	NC	Not connected
G	VCC	Voltage in 5V
H	SDA	I2C data
I	SCL	I2C Clock
J	NC	Not connected
K	NC	Not connected
L	GND	Ground
M	NC	Not connected
N	NC	Not connected
O	GND	Ground
P	B2-	Bridge 2 minus
Q	B2+	Bridge 2 plus
R	EXEC2+	Bridge 2 Excitation Plus

Virtual COM port SETTINGS

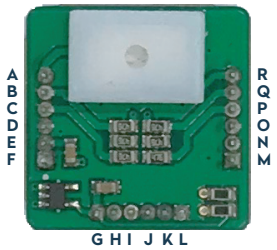
Voltage level: **5V**

Baud: **115200**

Data bits: **8**

Stop bits: **1**

Parity: **None**



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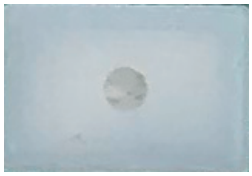
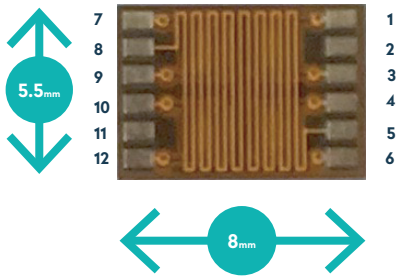
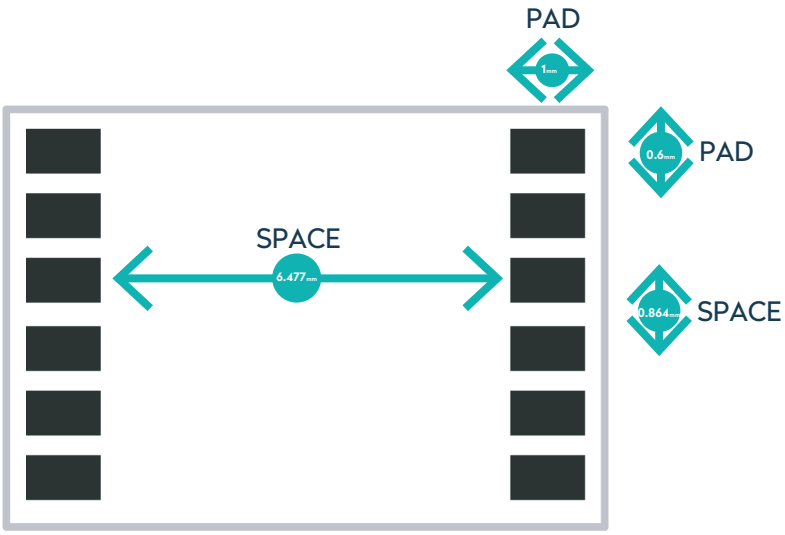
SENSOR PINOUT

Pin#	Function	Notes
1	S1+ Bridge	Bridge 1 Plus
2	NC	Not connected
3	S1- Exec1	Bridge 1 minus Excitation 1
4	S2+	Bridge 2 pluse
5	NC	Not connected
6	S2-	Bridge 2 minus
7	S3- Exec2	Bridge 3 minus
8	N/C	Not connected
9	S3+ Bridge 2-	Bridge 3 pluse
10	S4-	Bridge 4 minus
11	NC	Not connected
12	S4+	Bridge 4 pluse







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QUICK START
TERMINAL PROGRAM OPERATION

1. Download and install a Serial Plot.
(https://hackaday.io/project/5334-serialplot-realtime-plotting-software)

2. Connect the K9 Sensor Development Board to the Micro USB to USB on your computer.

3. Connect the USB to your computer.
   a. If device drivers are not automatically downloaded and installed, you can find device drivers for your operating system by going to:
   https://www.st.com/en/development-tools/stsw-stm32102.html

4. Determine the COM port that is associated with the module.
   a. On Windows operating systems, locate and open the Device Manager.
   b. The K9 Dev board should be listed under the heading, "Ports (COM & LPT)", as "STM Virtual COM Port", where XX is the unique port number associated with the device.
   c. Make a note of the unique port number.

5. Open SerialPlot.
   a. Underneath the graph window, look for the "Port" drop down menu.
   b. In the drop down list, select the appropriate COM port, identified above..
   c. Below the Port drop down menu, select the "Baud Rate" drop down menu, and
      - Baud: 115200
      - Data bits: 8
      - Stop bits: 1
      - Parity: None
      - Flow Control: None
   d. Select "OK"

6. Initial ZERO (Clean Air) Calibration.
   a. Takes up to 10 mins to establish baseline in new atmosphere.
   b. WAIT 30 mins - 1 hour to calibrate in clean air the longer the better.

SENSOR OPERATION

Sensor has an on-board eeprom so that it will be automatically identified by the development board.

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IMPORTANT PRECAUTIONS

All sensor designs are made for air monitoring @ 1 atm +/- 0.2 atm

Due to user applications of use and device implementation being outside our control, K9 Sensors cannot guarantee performance in a given device or application, therefore disclaiming any and all liability.

Customers should test under their own conditions to ensure the sensors are suitable for their requirements.

Contact the factory to discuss specific concerns that might damage the sensor performance or life.

- Condensation and Water [1]
- High Temperature Operation (> 40oC) for more than 1 month
- Low Humidity Operation (< 15% RH) for more than 3 months
- Highly contaminated air over a prolonged period
- High levels of particles or soot (unless proper filtering is provided) [2]

[1] Use of porous PTFE membrane or filter cap may address this concern.
[2] Use of replaceable filter recommended where dust and particulate is expected.

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SENSOR STORAGE, HANDLING AND SOLDERING

This information embodies various general recommendations concerning the storage, handling, and manual soldering conditions for K9 SENSORS modules. It is only applicable for modules guaranteed by K9 SENSORS stated in K9 SENSORS sensor specification sheet. Moreover, K9 SENSORS' modules are NOT warranted and should NOT be used in high temperature soldering (reflow) or pre-tinning baths.

Sensor & Module Handling

Handle sensors with care. Take precautions, including but not limited to the following:

A. DO NOT apply excessive pressure to the top or bottom of the sensor module.
B. Whenever possible, handle or make contact with the sensor module from the sides of the PCB or substrate.
C. Light vacuum pressure is possible during handling, DO NOT apply vacuum over gas sensor port.
D. If the sealed sensor package is opened, DO NOT re-seal using vacuum or nitrogen gas. DO NOT reseal with desiccant.
E. DO NOT obstruct the gas sensor port by making direct contact with any tape, apparatus, weights, etc.
F. DO NOT use silicone or other conformal coatings around the sensor or gas port-holes.
G. Operators are requested to wear powder free antistatic gloves.

Manufacturing Assembly Floor Environment

K9 SENSORS recommend that the manufacturing assembly floor environment be maintained at controlled conditions:

A. Temperature: 18 - 26°C
B. Relative Humidity: 40 to 60%
C. Pressure: 1.0 ± 0.2 atm

Sensor & Module Storage Conditions

The shelf life for sealed, packaged components is 12 months from the pack seal date, when stored in the factory sealed bag under the following conditions:

A. Temperature: 5 °C to 25 °C
B. Relative Humidity: 20 to 80%
C. Pressure: 1.0 ± 0.2 atm
D. Storage Time: 12 months

When moving from storage conditions to the manufacturing assembly floor environment, the sensors should be allowed to equilibrate at the new conditions for at least 24 hours prior to manufacturing.

Module Attach Soldering Process

Hand solder only. Keep the soldering iron or solder process tool away from the sensor. The sensor should not see preheat temperatures above 70 °C. There has been suggested cases where a heat sink cover over the sensor may be applicable to protect the sensor during processing. No application notes to this approach available.
Only to be used as reference only.

A. DO NOT heat sensor above 70 °C
B. Hand or peripheral process type approach
C. Use solder wire alloy with the lowest possible eutectic temperature
D. Use lowest possible soldering iron temperature
E. Contact the host board with the soldering iron at a 45° angle on the solder pad
F. Keep the soldering iron away from the top and bottom of the sensor module
G. DO NOT place in reflow, wave or IR reflow type processes
H. DO NOT place mounted board in a wash

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