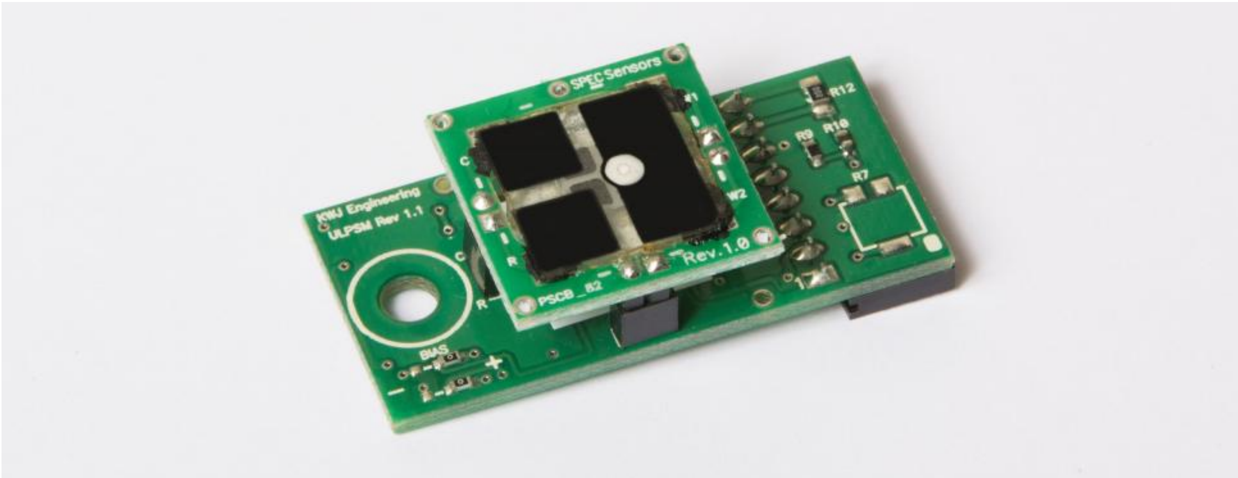
ULPSM-RESPIRR 968-009

October 2016

Ultra-Low Power Analog Sensor Module for Respiratory Irritants



BENEFITS

- **0 to 3 V Analog Signal Output**
- **Low Power Consumption < 45 µW**
- **Fast Response**
- **On-board Temperature Sensor**
- **Easy Sensor Replacement**
- **Standard 8-pin connector**

APPLICATIONS

- **Bad Air Quality Detection**
- **Indoor Air Monitoring**
- **Air Purifier Controls**
- **Smart Homes**
- **HVAC Ventilation control**
- **Internet of Things**

DESCRIPTION

Quickly integrate our respiratory irritant sensor for gases that cause ear, eyes and throat irritation into your system with very low power consumption and a simple analog sensor signal output.

The ULPSM converts the RESP-IRR sensor's linear current signal output to a linear voltage signal, while maintaining the sensor at its ideal biased operation settings.

MEASUREMENT PERFORMANCE CHARACTERISTICS

Measurement Range	0 to 20 ppm
Lower Detection Limit	0.3 ppm
Resolution	0.15 ppm
Accuracy	< ± 2 % of reading
Response Time T90	< 30 seconds
Power-On Stabilization Time	60 minutes recommended

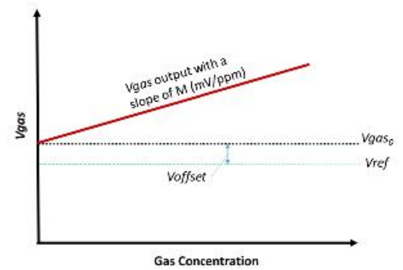
ABSOLUTE MAXIMUM RATINGS

Parameter	Conditions	Min.	Rec.	Max.	Units
Supply Voltage		2.7	3	3.3	V
Storage Temperature	Vapor sealed @ 50% RH	5	20	30	˚C
Storage Humidity	Non-condensing, Vapor sealed	20	50	80	% RH
Storage Pressure	Vapor sealed	0.8	1	1.2	atm.
Storage Time	Vapor sealed	-	12	-	Months
Operating Temperature	< 10 hours	-40	-	50	˚C
Operating Humidity	< 10 hours, Non-condensing	0	-	100	% RH
Operating Temperature	Continuous	-20	25	40	˚C
Operating Humidity	Continuous, Non-condensing	15	50	95	% RH
Operating Pressure	Continuous	0.8	1	1.2	Atm.

ELECTRICAL CHARACTERISTICS

Parameter	Conditions	Min.	Typ.	Max.	Units
Supply Current	V+ = 3.0 V	5	10	15	µA
Power Consumption	V+ = 3.0 V	15	30	45	µW
Vref			V+/2 - 0.1		V
Vgas Zero		(V+/2 – 0.1) – 0.005	V+/2 – 0.1	(V+/2 – 0.1) + 0.005	V
Vgas Span (M)	Room temperature	-12.5	-20	-27.5	mV/ppm

CALCULATING GAS CONCENTRATION



The target gas concentration is calculated by the following method:

$$Cx = \frac{1}{M} \cdot (Vgas - Vgas_0),$$

where *Cx* is the gas concentration (ppm), *Vgas* is the voltage output gas signal (V), $Vgas_0$ is the voltage output gas signal in a clean-air environment (free of analyte gas) and *M* is the sensor calibration factor (V/ppm). The value, *M*, is calculated by the following method:

$$M\left({}^{V}/_{ppm}\right) = Sensitivity\ Code\left({}^{nA}/_{ppm}\right) \times TIA\ Gain\left({}^{kV}/_{A}\right) \times 10^{-9}\left({}^{A}/_{nA}\right) \times 10^{3}\left({}^{V}/_{kV}\right),$$

where the *Sensitivity Code* is provided on the sensor label and the *TIA Gain* is the gain of the trans-impedance amplifier (TIA) stage of the ULPSM circuit. Standard gain configurations are listed in the table below.

The value $Vgas_0$ can also be represented by:

$$Vgas_0 = Vref + Voffset,$$

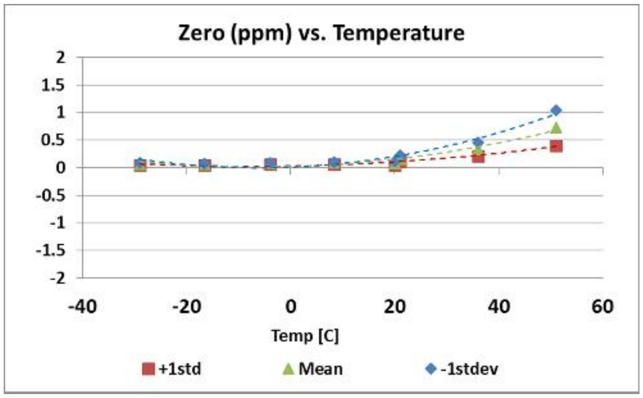
where, *Vref* is the voltage output reference signal (V) and *Voffset* is a voltage offset factor. The *Vref* output acts as the reference voltage for zero concentration even as the battery voltage decreases. Measuring *Vref* in-situ compensates for variations in battery or supply voltage, minimizing these effects on *Cx*. A difference amplifier or instrumentation amplifier can be used to subtract *Vref* from *Vgas*. Alternatively, when measuring *Vref* directly, always use a unity gain buffer.

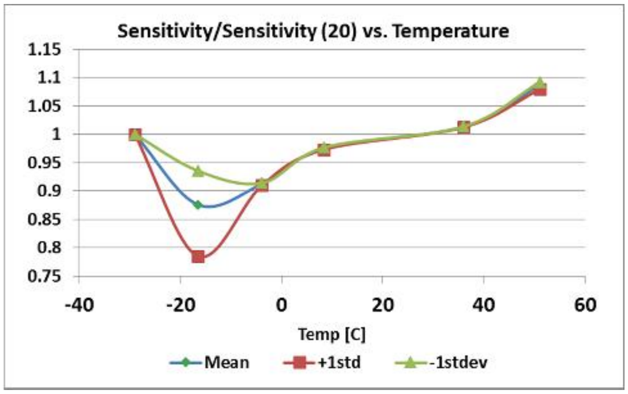
Voffset, accounts for a small voltage offset that is caused by a normal sensor background current and circuit background voltage. To start, *Voffset* = 0 is an adequate approximation. To achieve higher-precision measurements, *Voffset* must be quantified. Once the sensor has been powered-on and allowed to stabilize in a clean-air environment (free of the analyte gas) and is providing a stable output within your application's measurement goals, the value of *Vgas* may be stored as $Vgas_0$ and used in subsequent calculations of gas concentration, *Cx*.

Target Gas	TIA Gain (kV/A)
Carbon Monoxide	100
Hydrogen Sulfide	49.9
Nitrogen Dioxide	499
Sulfur Dioxide	100
Ozone	499
Ethanol	249
Indoor Air Quality	100
Respiratory Irritants	499

TEMPERATURE COMPENSATION

Temperature fluctuations have a predictable, easily compensated effect on the sensor signal**.** The figures below show the typical Temperature dependency of the output and baseline of respiratory irritant sensors under constant humidity of 40-50% RH. This is a very uniform and repeatable effect, easily compensated for in hardware or software.





From the graphs above:

- The temperature effect of zero shift is expressed as ppm change.
- The temperature effect of span (sensitivity) is expressed with respect to sensitivity at the calibration temperature of 20 °C.

When implementing temperature compensation, first correct the temperature effect on the zero (offset) and then correct the temperature effect on the span (sensitivity) of the sensor.

These corrections can be done in software by implementing one of the following:

- Curve fit
- Look up table
- A set of linear approximations, as outline in the following table.

Temperature Coefficient of Span (%/°C) ***(Typical)***	-20 °C to 20 °C	-0.33%/°C
	20 °C to 40 °C	0.26%/°C
Temperature Coefficient of Zero Shift (ppm/°C) ***(Typical)***	-20 °C to 0 °C	0.012 ppm/°C
	0 °C to 25 °C	0.056 ppm/°C
	25 °C to 40 °C	0.46 ppm/°C

CROSS SENSITIVITY

Most chemical sensors exhibit some cross-sensitivity to other gases. The following table lists the relative response of common potential interfering gases, and the concentration at which the data was gathered.

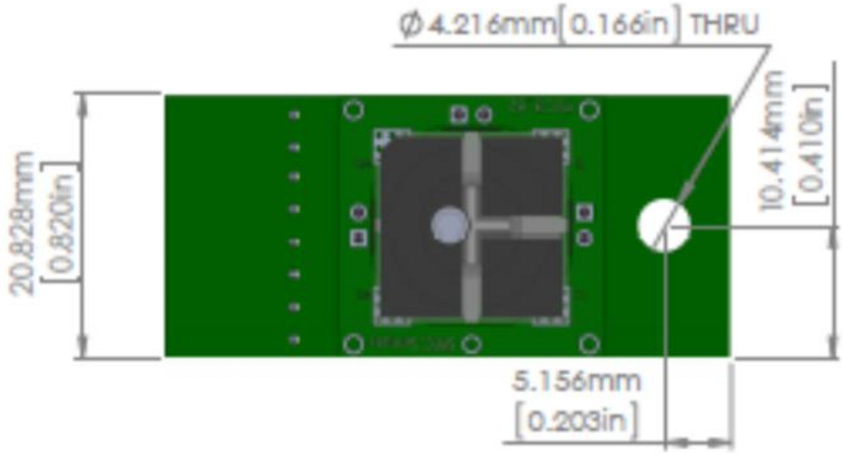
Gas/Vapor	Applied Concentration (PPM)	Typical Response (PPM CO)
Nitrogen Dioxide	10	10
Hydrogen Sulfide	10	27
Ozone	10	8
Chlorine	10	6.5
Ethanol	10	1
Sulfur Dioxide	10	-7
Carbon Monoxide	10	0
Nitric Oxide	10	0
Ammonia	10	0
n-Heptane	10	0
Methane	10	0
Saturated Hydrocarbons	10	0

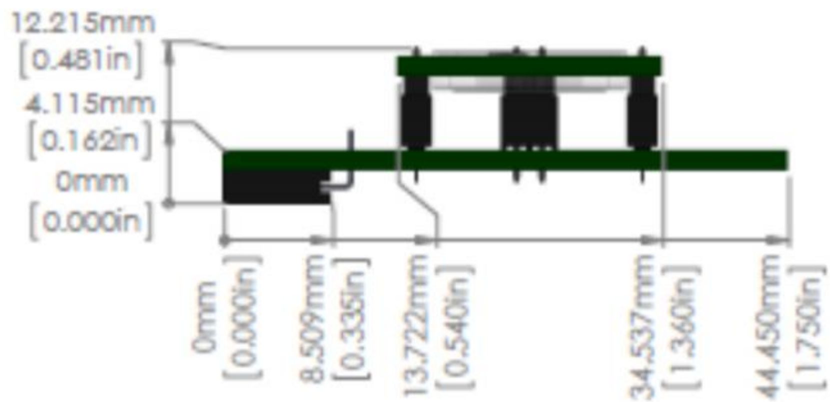
MARKING INFORMATION

All gas sensors are tested and marked at the SPEC Sensors factory. Sensors include a label with an alpha-numeric code and a two-dimensional bar code. The codes include the information indicated in the table below. (CO used for example)

	Unique Serial Number	Sensor Part Number	Target Gas	Date Code (YYMM)	Sensitivity Code (nA/ppm)
Alph-Numerica Code:		100102	CO	1510	4.94
2D Code:	101915010906	100102	CO	1510	4.94

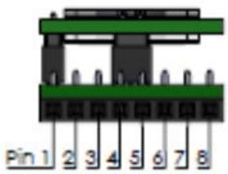
PACKAGE OUTLINE DRAWING & DIMENSIONS





PINOUT

Electrical connections to the ULPSM are made via a rectangular female socket connector (Sullins Connector Solutions P/N: PPPC041LGBN-RC; recommended mate for host board: P/N: PBC08SBAN). This connector also provides mechanical rigidity on one end of the board. A through-hole is located on the opposite end of the board to provide additional mechanical connection.



Pin #	ULPSM Function	Notes
1	Vgas	Voltage Output. Vgas is proportional to the target gas concentration.
2	Vref	Voltage Output. Vref is approximately half the supply voltage. Useful as a fixed reference; equivalent to zero for Vgas. NOTE: High impedance output requires a buffer to connect to any measurement device.
3	Vtemp	Voltage Output. Vtemp is proportional to temperature. NOTE: High impedance output requires a buffer to connect to any measurement device.
4	N/C	
5	N/C	
6	GND	Universal ground for power and signal
7	V+	Voltage Supply Input: 2.7 to 3.3 V
8	V+	Voltage Supply Input: 2.7 to 3.3 V

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