Sensor Development Kit

Ultra Low Power Sensor Module With Printed Sensors

The Small Ultra-Low Power Sensor Module (ULPSM) generates a linear voltage output proportional to gas concentration. This module combines SPEC Sensors' new ultra-thin electrochemical sensor technology with ultra-low-power analog voltage regulator circuits.

Printing sensor characteristics:

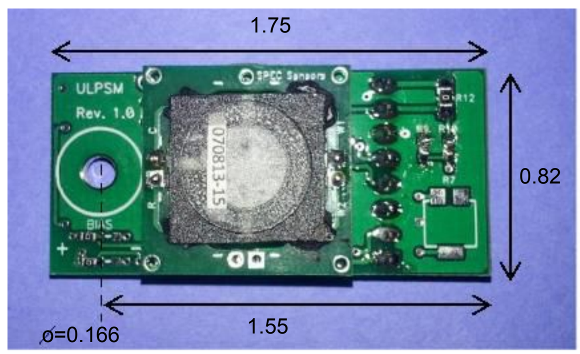
. Ultra-thin electrochemical sensor technology at the submillimeter level

Low cost, high performance

- Can be used for a variety of different target gases

Other sensors and configurations are available. Please contact us to discuss applications.

Target gas	maximum magnitude
Carbon monoxide-	1000 ppm
CO Sulfur dioxide-	50 ppm
H2S Nitrogen	20 ppm
dioxide-NO2	20 ppm
Ozone-O3	
Sulfur dioxide-SO	20 ppm 1000
2 Ethanol-CH6O	ppm

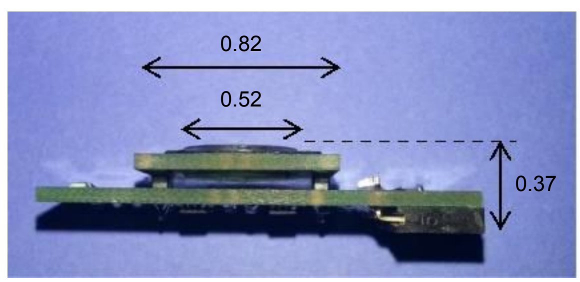


ULPSM characteris-tic :

. Ultra-low power consumption

- Small gas sensors and analog front-ends
- Low cost, easy to replace
- Standard 8-pin connector for easy integration
- In the temperature sensor on the board

The sensor joint allows the sensor to be replaced

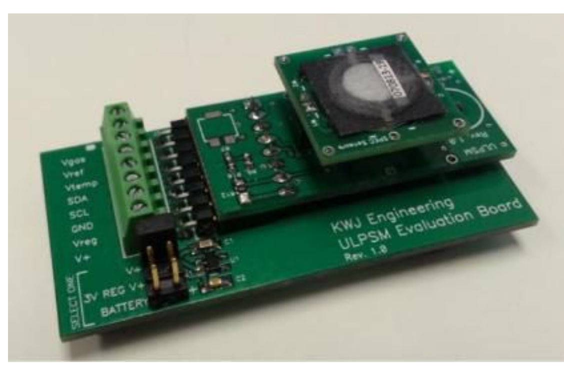


* All sizes are in inches

Evaluation board characteristics :

The plug is compatible with the recommended layout and is suitable for the user's implementation plan

The screw terminal is convenient to connect to external circuits and measuring equipment.



- Power options for jumper cables:
  - o CR2032 snap battery (included).
  - o External power supply: not adjusted, no fuse installed -Do not exceed 3.3 V input.
  - o External power supply: 3.0 V, adjustable-do not exceed 18 V input.

. Unit gain buffer for *Vref* and *Vtemp*

Insulating rubber pad feet

ULPSM device connection:

The ULPSM is electrically connected using a Sullins Connector Solution (Part: PPPC041LGBN-RC), recommended for motherboard accessories (Part: PBC08SBAN). This connector provides mechanical rigidity at one end of the board, while the through-hole or threaded gap (Option-C) at the other end offers additional mechanical fastening.

pin #	ULPSM function
1	*Vgas*
2	*Vref**
3	*Vtemp*
4	(*SDA*)*
5	(*SCL*)*
6	*GND*
7	(*Vreg*)*
8	*V+*

* selectable

Vgas: Voltage signal output, proportional to the target gas concentration throughout the specified range. For more details, see **Calculate gas concentration**.

Vre: voltage signal output, as a measurement reference for *Vgas*. The difference between them (*Vgas* - *Vre*) is not affected by the input voltage (*V+*). For more detailed information, refer to **calculating gas concentrations**.

Vtemp: Voltage signal output proportional to temperature. For more details, see **Calculate Temperature**.

SDA: Optional EEPROM I2C data line

SCL: Optional EEPROM I2C clock line

GND: Common ground for power and signals

Vreg: Optional voltage regulator output voltage. When not included, *Vreg* = *V+*.

V+: input voltage

Note: *Vref* and *Vtemp* are high-impedance outputs. A unit gain buffer should be applied between these pins and the measuring device (including voltmeters and analog-to-digital converters). The evaluation board includes a unit gain buffer for these outputs.

University gas sensor:

All gas sensors have been tested and calibrated at the SPEC Sensors plant. The sensors include a label printed with alphanumeric codes and a two-dimensional barcode. The table below shows the information contained in these codes.

	Unique Serial Number	Sensor Part Number	Target Gas	Date Code (YYMM)	Sensitivity Code (nA/ppm)
Alphabet-number code:	110201 CO 1501 5.57				
two-dimension code：	010715010101 110201 CO 1501 5.57				

Calculate gas concentration:

The sensors used for ULPSM are calibrated in the factory. The target gas concentration is calculated as follows:

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

Cx is the gas concentration (ppm), *Vgas* is the voltage output gas signal (V), *Vref* is the voltage output reference signal (V), *Voffset* is the voltage offset coefficient, *M* is the sensor calibration *number* (V/ppm). The value of *M* is calculated as follows:

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

Sensitivity encoding is provided on the sensor tag, and *TIA* gain is the transimpedance amplifier (TIA) gain of the ULPSM circuit. The right table lists the standard gain configurations.

objective gas	TIA gain (kV/A)
CO	100
H2S	49.9
NO2	499
SO2 O3	100 499
CH6O	249

Field measurement of *Vref* compensates for changes in battery or power supply voltage, minimizing the impact on *Cx* . Differential amplifier An op-amp or instrumentation amplifier can be used to subtract *Vref* from *Vgas*. Alternatively, when measuring *Vref* directly, it often causes
Use unit gain buffer. You can use a nominal value instead of measuring *Vref* .

When activated, the sensor reaches a stable state in a clean air environment (without analyte gas present), where the *Vgas* value nominally equals the *Vref* reference voltage. The *Voffset* represents a small offset voltage caused by the sensor's normal background current and circuit parasitic voltage. For most applications, an approximate assumption of *Voffset* = 0 is appropriate. To achieve more precise measurements, the final circuit configuration must quantize the *Voffset* within a clean air environment.

Calculate the temperature compensation gas concentration:

The first stage temperature compensation is carried out as follows:

$$Mc = M \cdot (1 + Tc \cdot (T - 20)),$$

Cxc represents the temperature-compensated gas concentration (ppm), *Mc* denotes the temperature compensation sensor calibration coefficient, *M* stands for the sensor calibration coefficient, *Tc* is the range temperature coefficient, and *T* indicates the measured temperature(.C). The SDK system datasheet in the USB drive provides the calibration coefficient *Tc*, which can also be calculated through curves specified in specialized sensor datasheets.

Calculate temperature:

Within the range of-10°C to 50°C, temperature (℃, ±3℃) is calculated according to the following theoretical relationship:

$$T = \left({}^{87.0}/_{V+}\right) \cdot Vtemp - 18.0. \quad \cdot ef - Voffset),$$

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