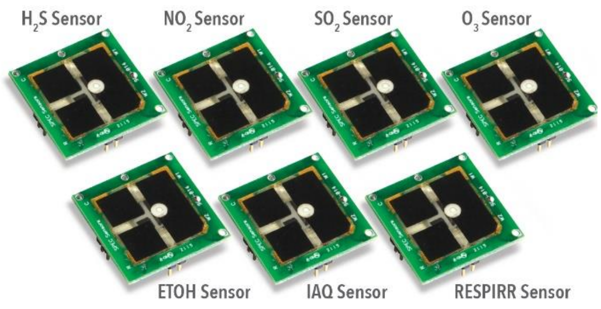
Digital Gas Sensor Developer Kit 968-045

August 2017

DGSDK



- **Works with 3V supply**
- **Low power: 100 µW in standby mode**
  Outputs
  - **Temperature**
  - **Relative Humidity**
  - **Gas Concentration**
- **Simple digital UART Interface**
- **ROHS compliant**
- **Small form Factor (0.8 x 1.75 x 0.35")**
- **Lightweight (< 2 oz.)**

COMPONENTS USED

- **Texas Instruments LMP91000**
- **Microchip PIC24F16**
- **SiLabs SI7021**
- **Microchip MCP604**
- **Intersil ISL60002**

APPLICATIONS

- **Carbon monoxide safety alarms**
- **Air pollution monitoring**
- **Indoor air quality**
- **Breath analysis**
- **Generator control**

CONTENTS INCLUDES

- **Digital Gas Sensor platform**
- **One sample of every SPEC Sensor**
- **UART to USB adapter**
- **Link to setup and logging utility**
- **Link to full design documentation**
  - **Schematic**
  - **Parts List (BOM)**
  - **Gerber/design files**
  - **Firmware**

DIGITAL GAS SENSOR PLATFORM

DESCRIPTION

SPEC Sensors is making it easy for Internet of Things developers to integrate gas sensing in their products. Carbon Monoxide Alarms, Air Pollution Monitoring, Indoor Air Quality, and Breath Analysis are some of the gas sensing applications that demand high performance measurement. Electrochemical gas sensing technology is the preferred solution for these applications due to measurement performance and the ultra-low power consumption needed for battery operation.

SPEC Sensors has overcome the physical size and mass market volume limitations that have constrained market adoption of electrochemical gas sensing in consumer products. The Digital Gas Sensor Developer Kit will allow OEMs to quickly integrate gas sensing into their application(s).

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MEASUREMENT PERFORMANCE CHARACTERISTICS

Gas Sensor	Measurement Range	Resolution (1)
Carbon Monoxide – CO	1000 ppm	100 ppb
Hydrogen Sulfide – H2S	10 ppm	10 ppb
Nitrogen Dioxide – NO2	5 ppm	< 20 ppb
Sulfur Dioxide – SO2	20 ppm	50 ppb
Ozone – O3	5 ppm	< 20 ppb
Ethanol – ETOH	800 ppm	300 ppb
Indoor Air Quality (combustion)	400 ppm (CO equivalent)	100 ppb
Respiratory Irritants	20 ppm (NO2 equivalent)	< 20 ppb

NOTE 1: Based on Standard Deviation of noise at 0 ppm, 1 Hz measurement 60 second averaging.

Based on Standard Conditions 25° C, 50% RH and 1 atm	
Measurement Accuracy	15% of reading (using bar code sensitivity and average comp)
Measurement Repeatability	± 3 % of reading
Recommended Warm-Up Time	60 minutes from power applied to USB port
Power Consumption	100 µW in standby mode 14 mW in measurement mode
Expected Operating Life	> 5 years (10 years @ 25 ± 10 °C; 60 ± 30% RH)
Operating Temperature Range	-20 to 40 °C (-30 to 55 °C intermittent)
Operating Humidity Range	15 to 95% (0 to 100% non-condensing intermittent)
Mechanical Dimensions	1.75 x 0.82 x 0.35 in. (44.5 x 20.8 x 8.9 mm)
Weight	< 2 Ounces

ABSOLUTE MAXIMUM RATINGS

Parameter	Conditions	Min.	Rec.	Max.	Units
Maximum Concentration	Short term exposure	0	1000	5000	ppm
Supply Voltage	Regulated	2.6		3.6	mV
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 Pressure	Transient pulses	-.5	0	.5	atm
Operating Temperature	Continuous	-30	25	50	°C
Operating Humidity	Continuous, Non-Condensing	10	50	95	% RH
Operating Pressure	Continuous	0.8	1	1.2	atm
ESD Rating	Human Body Model	2		8	kV

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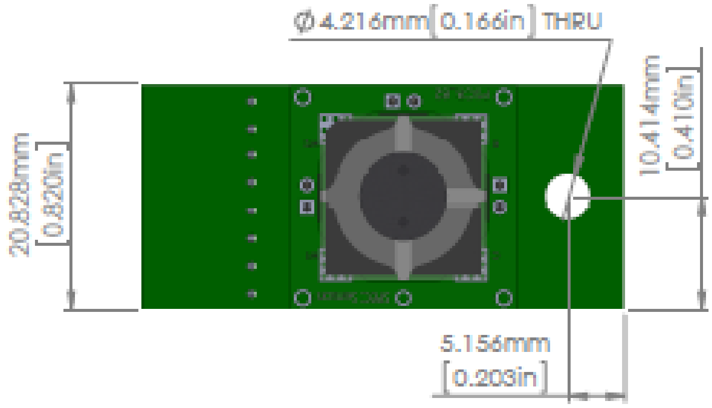
ELECTRICAL CHARACTERISTICS

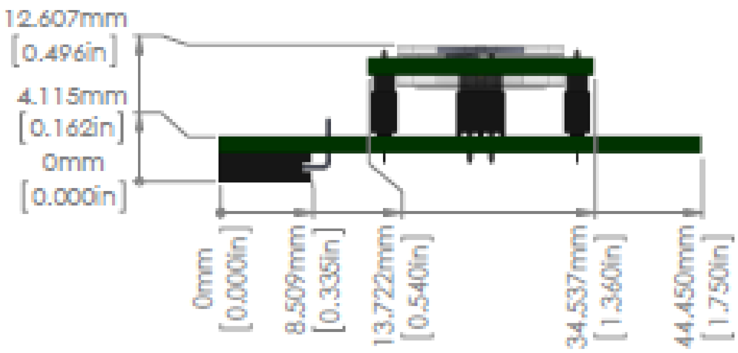
Parameter	Conditions	Min.	Typ.	Max.	Units
Supply Current	V+ = 3.3 V	0.03		4.3	mA
Power Consumption	V+ = 3.3 V	0.1		14	mW

CROSS SENSITIVITY

Refer to the cross-sensitivity information in the datasheet for the sensor in use.

PACKAGE OUTLINE DRAWING & DIMENSIONS





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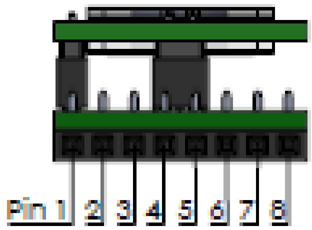
PINOUT

Electrical connections to the DGS 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#	Function	Notes
1	N/C	
2	RXD	
3	TXD	
4	N/C	
5	N/C	
6	GND	
7	N/C	
8	V+	Voltage Supply Input: 3.0 to 3.6 V



USB to UART BRIDGE SETTINGS

- Voltage level: 3.3 V
- Baud: 9600
- Data bits: 8
- Stop bits: 1
- Parity: None
- Flow Control: None

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QUICK START – TERMINAL PROGRAM OPERATION

1. **Download and install a terminal program, such as Tera Term.**

2. **Connect the DGS to the USB to UART Bridge via the adapter board.**

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 searching www.silabs.com for: “CP210x USB to UART Bridge VCP Drivers”.

4. **Determine the COM port that is associated with the module**
   a. On Windows operating systems, locate and open the Device Manager.
   b. The DGS device should be listed under the heading, “Ports (COM & LPT)”, as “Silicon Labs CP210x USB to UART Bridge (COMXX)”, where XX is the unique port number associated with the device.
   c. Make a note of the unique port number.

5. **Open Tera Term and establish a serial connection with the module**
   a. In the “New Connection” window, select the “Serial” radio button.
   b. In the drop down list, select the appropriate COM port, identified above, then Select “OK”.
   c. On the Menu bar, select “Setup”, then “Serial port…” Use: *USB to UART BRIDGE SETTINGS*
      - Voltage level: 3.3 V
      - Baud: 9600
      - Data bits: 8
      - Stop bits: 1
      - Parity: None
      - Flow Control: None
   d. Select “OK”

6. **Start Continuous Measurement in Terminal Window**
   a. Type *any key* to exit low-power standby mode.
   b. Press the Enter key (‘\r’) to transmit a single measurement string.
   c. Type ‘c’ (lower-case c, without quotation marks) to start continuous output.
   d. The format of the output is:
   SN, PPB, T (°C), RH (%), ADC Raw, T Raw, RH Raw, Day, Hour, Minute, Second
   e. Type ‘c’ to stop the continuous output
   f. Type ‘s’ to enter low-power standby mode

7. **Initial ZERO (Clean Air) Calibration**
   a. When first given power after a long period of unpowered storage, the sensor needs to stabilize in clean air to its zero offset current.
   b. WAIT at least 1 hour in clean air while ensuring the computer and USB port have not gone to sleep.
   c. Type ‘Z’ in the terminal window to re-zero the sensor output.

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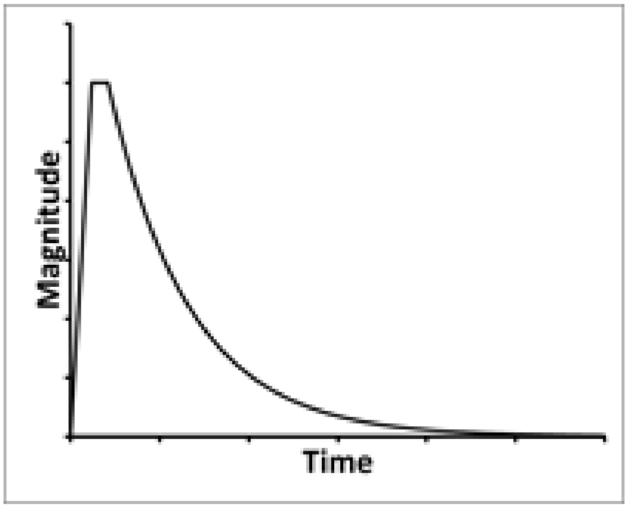
NORMAL SENSOR STARTUP FROM HAVING NO POWER APPLIED

The electrochemical sensor output has the normal startup profile pictured here. When powering the sensor, its output will rapidly increase followed by a gradual decrease. Once this process is complete, the sensor output will be the most accurate and stable. The time and magnitude of this response may vary depending on the sensor type and the length of time the sensor has been unpowered.

It is recommended that the module remains always on power. For the greatest accuracy, the DGS module should *not* be placed in low-power standby mode between measurements. When *not* in low-power standby mode, a running average may be implemented to improve signal noise (at the expense of response time). By default, the running average is set to n = 1 (no averaging). The value of n may range from 1 to 300.



DGS OPERATION

When the DGS is connected to V+ and GND: The module's microprocessor will automatically configure the sensor and circuit for operation and then enter a low-power standby mode. While in standby mode, critical sensor circuitry remains active.

If the module is powered and in low-power standby mode: Any data (i.e. single key stroke) received on the UART interface will exit the standby mode. To transmit a single measurement string, press the return key ('\r'). There is up to a 1 second delay between when the module receives a command and when the module transmits a response. To transmit a continuous stream of measurement strings at a rate of once per second, type 'c'. To stop the continuous data, type 'c' again. When the module is not in standby mode it measures and averages the data in the background, regardless of the transmission state. To re-enter the low-power standby mode, type 's'.

NOTE: When entering commands via a script or software, allow for a small delay in between all characters.

COMMAND LIBRARY

To execute one of the following commands, send the corresponding case-sensitive ASCII character via UART.

NOTE: When entering commands via a script or software, allow for a small delay in between all characters.

\r [Enter key] TRANSMIT single measurement string

c CONTINUOUS data output

The module transmits measurement strings at a rate of 1 per second

Press 'c' to exit

s STANDBY mode

The module enters a low-power standby mode (press any key to exit).

B BARCODE entry

The module is initially configured at the factory based on the barcode sticker on the back of the sensor.

Example Barcode: 090115020653 110109 CO 1509 5.21\r ('\r' denotes Enter key)

Z ZERO user calibration

The sensor is re-zeroed such that the module output is 0 ppm.

S SPAN user calibration

The sensor nA/PPM value is recalculated such that the output matches the entered value.

A AVERAGE

Changes the number of samples in the running average (1 to 300)

T TEMPERATURE calibration

Adds offset (positive or negative) to temperature sensor measurement

L LMP91000 manual setting

Allows the user the manually set the LMP91000. Refer to the LMP91000 datasheet for information on the settings.

Incorrect settings may damage the sensor.

R or r RESETS the module

l LMP910000 read

Transmits the LMP91000 settings.

f FIRMWARE readout

Displays the firmware revision date

e EEPROM readout

Stored module parameters are output for diagnostic purposes.

Add: 16/F, Bldg. #3, Zhongke Mansion, No.1 Hi-Tech S. Rd, Hi-Tech Park South, Shenzhen, Guangdong, 518067 P.R.China

Tel: + 86-755-83289036 Fax: + 86-755-83289052 E-mail: sales@isweek.com

EXAMPLE BARCODE PROCEDURE

('B')

Remove Sensor and Scan: 090115020653 110401 O3 1509 -12.11 (return key pressed)
Setting OC...done
Setting zero...done

EXAMPLE ZERO PROCEDURE

('Z')

Setting zero...done

EXAMPLE SPAN PROCEDURE

('S')

Enter span gas value in PPM: 2 (return key pressed after 2)
Setting span...done

EEPROM EXAMPLE OUTPUT

('e')

EEPROM Values
nA_per_PPM_x100= -1036
ADC_OC= 32722
ADC_Zero= 32721
ADC_Span= 32390
Temperature_Offset_x1000= -1
T_Zero= 25989
RH_Zero= 31266
T_Span= 26164
RH_Span= 31042
LMP91000 Register 0x10= 3
LMP91000 Register 0x11= 161
LMP91000 Register 0x12= 3
Average_Total= 1
Barcode= 090115020653 110401 O3 1509 -12.11
Serial_Number= 090115020653

Part_Number= 110401
Gas= O3
Date_Code= 1509
Sensitivity_Code= -12.11

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IMPORTANT PRECAUTIONS

All sensor designs are made for air monitoring @ 1 atm +/- 0.2 atm. Because applications of use and device implementation are outside our control, SPEC Sensors cannot guarantee performance in a given device or application, and disclaims any and all liability therefore. **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 (> 40C) 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 SPEC SENSORS CSPEC Modules. It is only applicable for modules guaranteed by SPEC SENSORS stated in SPEC SENSORS Sensor Specification Sheet. Moreover, SPEC 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
SPEC SENSORS recommends 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 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 pre-heat temperatures above 70 °C. There have 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