

## Gas Sensor Board (#27983)

The Gas Sensor Board is designed to work in conjunction with one of the gas sensors listed below (not included) allowing you to determine when a preset gas level has been reached or exceeded.

- CO (Carbon Monoxide) Gas Sensor (#605-00007)
- CH<sub>4</sub> (Methane) Gas Sensor (#605-00008)
- LPG (Propane) Gas Sensor (#605-00009)
- C<sub>2</sub>H<sub>5</sub>OH (Alcohol) Gas Sensor (#605-00011)

The board can interface to a microcontroller, allowing the sensor to be controlled and monitored automatically. Interfacing with the Gas Sensor Board is done through a 4-pin SIP header and requires two I/O pins from the host microcontroller. The Gas Sensor Board is intended to provide a means of comparing gas sources and being able to set an alarm limit when the source becomes excessive.

The Gas Sensor Board and individual gas sensors replace the discontinued product numbers listed below. Please note that on boards labeled 27983 pin 2 is active-high, and on boards labeled 27904, 27930, 27931, and 27932, pin 2 is active-low.

- #27983 + #605-00007 replaces #27931 – CO Gas Sensor Module
- #27983 + #605-00008 replaces #27930 – CH<sub>4</sub> Gas Sensor Module
- #27983 + #605-00009 replaces #27932 – LPG Gas Sensor Module
- #27983 + #605-00011 replaces #27904 – C<sub>2</sub>H<sub>5</sub>OH Gas Sensor Module

**Parallax does not provide gas calibration data on these sensors and such data as well as the alarm settings are the responsibility of the user to define. For information on calibration please see page 3.**

### Features

- Easy SIP header interface
- Compatible with most microcontrollers
- Low-power standby mode

### Application Ideas

- Gas level over-limit alarm
- Stand-alone/background sensing device
- Environmental monitoring equipment

### Key Specifications

- Power requirements: 5 VDC @ ~165 mA (heater on) / ~60 mA (heater off)
- Interface: 1 TTL compatible input (HSW); 1 TTL compatible output (ALR)
- Operating temperature: 14 to 122 °F (-10 to +50°C)
- Dimensions: 1.50 x 1.0 x 1.0 in (38.1 x 25.4 x 25.4 mm)

### Other Items Required

- Tiny flat-head screwdriver
- A source of gas for calibration
- Gas sensor (listed above)

## Precautions

Be aware that the gasses detected by these gas sensors can be deadly in high concentrations. Automotive exhaust and charcoal cooking grill exhausts emit carbon monoxide (CO). Propane Gas (LPG) can leak from propane grills and furnaces and Methane (CH4) can be found in animal farming areas. Always be careful to perform gas tests in well-ventilated areas.

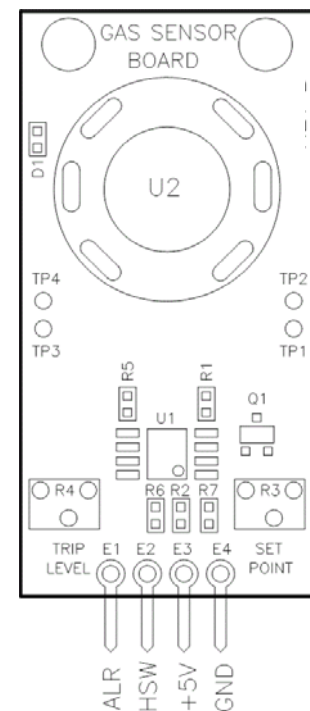
THE GAS SENSOR BOARD IS NOT DESIGNED FOR OR APPROVED FOR ANY APPLICATION INVOLVING HEALTH OR HUMAN SAFETY. THE GAS SENSOR BOARD IS FOR EXPERIMENTAL PURPOSES ONLY. PARALLAX, INC. ABSOLVES ITSELF OF ALL LIABILITY AND RESPONSIBILITY ASSOCIATED WITH THE CUSTOMER'S USE OF THE GAS SENSOR BOARD AND IS NOT RESPONSIBLE FOR ANY BODILY INJURY, DEATH OR PROPERTY DAMAGE AS A RESULT OF USING THE GAS SENSOR BOARD.

## Connecting and Testing

The gas sensor canister plugs into the socket on the front of the board. The gas sensors are essentially resistive devices and are not polarized, so there is no need to be concerned about plugging it in "backwards." It will work in either orientation.

The 4-pin SIP header on the Gas Sensor Board makes it easy to connect to a breadboard or SIP socket. The four connections are defined in the table below. Connection to a 5V microcontroller, such as the BASIC Stamp® module, would be pretty straight forward and require two I/O pins; one input for detecting the alarm signal (ALR) and the other an output for controlling the internal heater (HSW).

For a 3.3 V microcontroller such as the Propeller™ chip, a 3.9 kΩ–10 kΩ resistor would be required from the ALR output to the Propeller chip input pin.



## Pin Definitions and Ratings – Gas Sensor Board

Pin	Name	Function	Level
E1	ALR	Alarm output to host microcontroller	0V / 5V
E2	HSW	Heat switch input from microcontroller, active high	0V / High*
E3	+5V	+5 VDC power	5V
E4	GND	Ground, connects to common ground	0V
TP1	Test Point 1+	Buffered output of sensors (voltage divider)	0V – 5V
TP2	Test Point 2-	Ground, connects to common ground	0V
TP3	Test Point 3+	Trip Level voltage set by potentiometer (R4)	0V – 5V
TP4	Test Point 4-	Ground, connects to common ground	0V

\* The HSW can be activated from 3-5 VDC and has an internal 150 kΩ pull-down resistor.

NOTE: Sensors may rattle if shaken – this is normal.

## Theory of Operation

The gas sensor board uses gas sensors from Hanwei Electronics. When their internal heating elements are activated, they respond to their specific gas by reducing their resistance in proportion to the amount of that gas present in the air exposed to the internal element. On the gas sensor board this is part of a voltage divider formed by the internal element of each gas sensor and potentiometer R3 (Set Point). The output of this voltage divider is fed into the non-inverting inputs of the two op-amps on the LT1013 dual op-amp IC. Op-amp A is configured as a buffer with unity gain and is used to provide a non-loaded test point for the signal voltage at TP1 (+) and TP2 (-). The signal voltage is also being fed into op-amp B which is configured as a comparator that gets its reference voltage at the inverting input from potentiometer R4 (Trip Level) and is also available at TP3 (+) and TP4 (-).

The output of op-amp B goes out to the ALR pin through a 1 k $\Omega$  resistor providing a TTL-compatible signal to a microcontroller. This output also connects to a red LED on the Gas Sensor Board. The zero gas span adjustment is set via potentiometer R3. As mentioned above R3 allows you to change the span/range of the voltage divider formed by the gas sensor and R3 which is the bottom leg of the divider, electrically speaking. Adjusting R3 to lower values will make the gas sensor less sensitive but more stable. Avoid setting R3 below 200 ohms as at this point you will be close to shorting the output to ground. Setting R3 to higher values will make the gas sensor more responsive, but without a minimum load it will become unstable after a certain point and drift. The trip level adjustment is set via potentiometer R4. This is just a simple voltage divider that lets you set the voltage from 0V to 5V. This voltage is compared to the voltage coming from the gas sensor/R3 divider. When the voltage from the gas sensor is higher than the voltage set by potentiometer R4 the red LED will light and the ALR output will be high (5 V). The section below describes how to configure these Gas Sensor Boards to detect gas with minimal calibration.

One more important item to consider when setting R3 during calibration is the load resistance recommended in the datasheet for each gas sensor. Potentiometer R3 should be set as close as possible to the load resistance recommended for the gas sensor you're using.

## Calibration

The procedure for setting these potentiometers is explained below. Please note that turning the potentiometer clockwise decreases voltage, while turning the potentiometer counter-clockwise increases it. This can be compared to a water valve.

- For the CO sensor, please read the CO Sensor Specifics on page 4 before attempting calibration.
- Place the Gas Sensor Board in a clean air environment and supply power to the board. The heater should be active during this time. Allow at least 10 minutes before making adjustments.
- Adjust potentiometer R4 until the voltage across TP3 (+) and TP4 (-) reads  $\sim 0.80$  V.
- Adjust potentiometer R3 until the voltage across TP1 (+) and TP2 (-) reads  $\sim 0.80$  V.
- At this point adjusting R3 up/down should make the LED toggle on/off. Adjust R3 so the LED just goes off.
- Apply your gas source to the gas sensor. The LED should light up.
- Remove the gas source and allow the sensor to settle. The LED should go back out.
- If the LED does not go out within 60 seconds, adjust R3 until the LED goes out and repeat the two previous steps.

The gas sensor board's ALR pin should only be checked when the heater is on and the readings have stabilized. Note that temperature and humidity are factors that could affect the sensor, making calibration difficult. If this should happen try adjusting the voltages used in the calibration up or down as necessary to find a more stable range.

## CO Sensor Specifics

The CO gas sensor must cycle through alternating voltages on its heater when active. This is unlike the CH<sub>4</sub>, LPG, and C<sub>2</sub>H<sub>5</sub>OH gas sensors where the heater is on or off. To sense CO gas using the CO gas sensor the heater must be driven at 5 V (full power) for the purge phase and 1.4 V (low power) for the sense phase. The full-power (purge) phase runs for 60 seconds and the low-power (sense) phase runs for 90 seconds. These phases cycle continuously as long as the sensor is active. The ALR output is checked during the sense phase only. Checking it during the purge phase or when the heater is not active could result in false positives.

In order to power the CO gas sensor from 5V and still obtain 1.4 V for the sense phase it is necessary to pulse-width modulate (PWM) the HSW pin. Example source code is provided for the BASIC Stamp 2 module (see your gas sensor's product page; search by stock code at <http://www.parallax.com>) and Propeller chip (see the Propeller Object Exchange, <http://obex.parallax.com>).

## Sources of Gas for Calibration / Testing

The use of a standard butane hair curler is an easy, safe source to use for a very low carbon monoxide (CO) gas concentration (less than 500 ppm) and can be used during calibration and testing with the CO Gas Sensor.

An unlit propane torch can be used as a source for calibration and testing with the LPG Gas Sensor. These are readily available from any hardware store and most department stores. Be careful not to leave the valve open very long. Simply cracking the valve just a little can trigger the gas sensor.

We have not found an easy reliable source of methane for calibration and testing with the CH<sub>4</sub> Gas Sensor, however this sensor is responsive to propane as well so that could be used for testing.

Breathing gently through a small plastic tube (a drinking straw will work) can be used for calibrating with the C<sub>2</sub>H<sub>5</sub>OH Gas Sensor. The tube will help get the gas to the sensor and should condense most of the water vapor in your breath that may interfere with the sensor. Breathe out very, very slowly! Air movement across the sensor can cool the heater, causing erroneous readings.

## Resources and Downloads

You may download the Gas Sensor Board schematic as well as the manufacturer datasheet for the sensors from each item's product page. Go to <http://www.parallax.com>, and search by the specific product number.

For gas calibration information you can also visit the following PDF on this website:  
<http://www.gotgas.com/pdf/GasSnsrCalibratn.pdf>