

## CH4 Gas Sensor Module (#27930)

## CO Gas Sensor Module (#27931)

## LPG Gas Sensor Module (#27932)

These Gas Sensor Modules are designed to allow a microcontroller to determine when a preset gas level has been reached or exceeded. The type of gas detected depends on which module you are using. 27930 detects Methane (CH<sub>4</sub>), 27931 detects Carbon Monoxide (CO) and 27932 detects Propane (LPG). Interfacing with these sensors is done through a 4-pin SIP header and requires two I/O pins from the host microcontroller. The sensor modules are intended to provide a means of comparing gas sources and being able to set an alarm limit when the source becomes excessive. **Parallax does not provide gas calibration data on these modules 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: 32 to 158 °F (0 to 70°C)
- Dimensions: 1.50 x 1.0 x 1.0 in (38.1 x 25.4 x 25.4 mm)

### Packing List

- Gas Sensor
- Gas Sensor PCB Assembly
- Potentiometer adjustment tool

### 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 (CH<sub>4</sub>) can be found in animal farming areas. Always be careful to perform gas tests in well-ventilated areas.

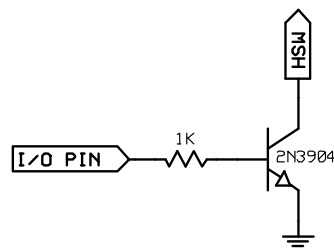
**THESE GAS SENSOR MODULES ARE NOT DESIGNED FOR OR APPROVED FOR ANY APPLICATION INVOLVING HEALTH OR HUMAN SAFETY. THESE GAS SENSOR MODULES ARE FOR EXPERIMENTAL PURPOSES ONLY. PARALLAX, INC. ABSOLVES ITSELF OF ALL LIABILITY AND RESPONSIBILITY ASSOCIATED WITH THE CUSTOMER'S USE OF THESE GAS SENSOR MODULES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

## Connecting and Testing

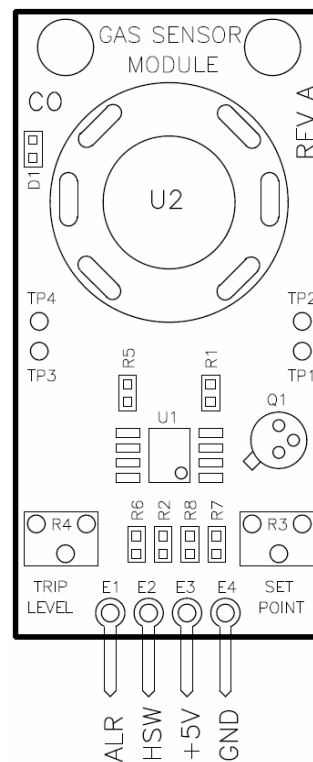
The gas sensor canister plugs into the socket on the front of the module. The gas sensors are essentially resistive devices and are not polarized, so there is no need to be concerned about plugging it in “backwards.” It will work in either orientation.

The 4-pin SIP header on the Gas Sensor Module 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 and the other an output for controlling the internal heater.

For a 3.3V microcontroller such as the Propeller™ chip, a 3.9 kΩ (10 kΩ could be used) resistor would be required from the ALR output to the Propeller chip input pin. For the Propeller to control the heater switch input (HSW) you would need an NPN switching transistor, such as a 2N3904 and a 1 kΩ resistor. The schematic for this connection is shown below.



Switching circuit for the Propeller chip. Note HIGH signal required to turn on heater due to inversion of signal by the transistor.



## Pin Definitions and Ratings

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

\* The HSW line is internally pulled up to 5 V via a 10 kΩ resistor.

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

## Theory of Operation

These gas sensor modules use gas sensors from Hanwei Electronics. When their internal heating elements are activated, these gas sensors 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 modules this is part of a voltage divider formed by the internal element of each gas sensor and potentiometer R3. 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 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 modules. 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. 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 modules to detect gas with minimal calibration.

## 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 Module in a clean air environment and supply power to the module. The heater should be active during this time. Allow at least 10 minutes before making adjustments.
- Adjust potentiometer R4 (Trip Level) until the voltage across TP3 (+) and TP4 (-) reads approximately 0.80 V.
- Adjust potentiometer R3 (Set Point) until the voltage across TP1 (+) and TP2 (-) reads approximately 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 module's ALR pin should only be checked when the heater is on and the readings have stabilized.

Note: 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> and LPG 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 (page 6) 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 of the CO Gas Sensor Module.

An unlit propane torch can be used as a source for calibration and testing of the LPG Gas Sensor Module. 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 of the CH<sub>4</sub> Gas Sensor Module, however the CH<sub>4</sub> gas sensor is responsive to propane as well so that could be used for testing.

## Resources and Downloads

You may download free example programs, the manufacturer datasheet, etc. from each gas sensor's product page on our website by browsing to <http://www.parallax.com> and typing the specific product number into our search box and clicking, "GO."

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



## BASIC Stamp<sup>®</sup> 2 Program

This program is designed for the BASIC Stamp 2 and a CO Gas Sensor (#27931).

```
' =====
' File..... CO Gas Sensor.bs2
' Purpose... Runs the CO Gas Sensor Module Heater
' Author.... Parallax, Inc.
' E-mail.... support@parallax.com
' Started... 02-09-2009
' Updated...
'   {$STAMP BS2}
'   {$PBASIC 2.5}

' -----[ Program Description ]-----
' This program runs the Gas Sensor Heater through two phases (voltages) as
' recommended by the manufacturer datasheet. The sensor should run for at
' least 10 minutes in clean air before any calibration is done.

' The first phase is the PURGE phase where the heater element is turned on
' at a full 5V. This clears the sensor and no checking for an alarm
' condition is done here. The DEBUG screen will count down the 60 seconds
' of this phase.

' The second phase is the SENSE phase where the heater element is run at
' ~1.4V for 90 seconds. It is during this phase that the sensor can be
' calibrated or that the sensor is checked for alarm conditions.

' -----[ I/O Definitions ]-----
HSW          PIN      0          ' Heater Switch Control
ALR          PIN      1          ' Alarm Input Sense

' -----[ Variables ]-----
index        VAR      Word      ' Counter Variable

' -----[ Program Code ]-----
Main:
DO
  LOW HSW          ' Turn Heater ON
  FOR index = 59 TO 0 ' Count Down 60 Seconds
    DEBUG HOME, "PURGE MODE...", DEC2 index, "      "
    PAUSE 1000     ' 1 Second Pause
  NEXT
  index = 1710    ' Approximately 90 Seconds
  DO
    DEBUG HOME, "SENSE MODE...", DEC2 index / 19
    LOW HSW      ' Turn Heater ON
    PAUSE 15     ' For 15 ms
    INPUT HSW    ' Turn Heater OFF
    PAUSE 3      ' For 3 ms
    index = index - 1
    IF ALR = 1 THEN ' Check For Alarm Condition
      DEBUG " ***ALARM***" ' Display Alarm Condition
    ELSE
      DEBUG "      " ' Clear Alarm Condition
    ENDIF
  LOOP UNTIL index = 0 ' End Of Sense Mode Loop
LOOP
```