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CO Gas Sensor Module (#27931)

The CO Gas Sensor Module is designed to allow a microcontroller to determine when a preset carbon monoxide gas level has been reached or exceeded. Interfacing with the sensor module is done through a 4-pin SIP header and requires two I/O pins from the host microcontroller. The sensor module is mainly intended to provide a means of comparing carbon monoxide sources and being able to set an alarm limit when the source becomes excessive. **Parallax does not provide gas calibration data on the module and such data and alarm setting is the responsibility of the user to define. For information on user calibration please see page 3.**

Features

- Uses the MQ-7 CO Gas Sensor
- Easy SIP interface
- Compatible with most microcontrollers

Application Ideas

- Sensing high carbon monoxide (CO) concentration
- Alert for over-limit of gas concentration
- Stand-alone/background sensing device

Key Specifications

- Power requirements: 5VDC @ 165 mA (Purge Phase) / 50 mA (Sense Phase)
- Interface: 1 TTL compatible input (HSW), 1 TTL compatible output (ALR)
- Operating temperature: 32 to 158 °F (0 to 70 °C)
- Dimensions: 1.5 x 1 x 1 in (38.1 x 25.4 x 25.4 mm)

Packing List

- CO Gas Sensor Module
- Potentiometer Adjustment Tool
- Documentation

Precautions

Be aware that a carbon monoxide concentration greater than 1000 parts ppm (parts per million) is deadly. Automotive exhaust and charcoal cooking grill exhausts can be above 1000 ppm in carbon monoxide.

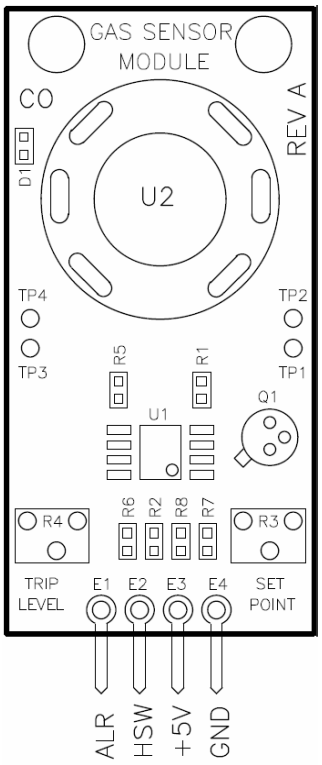
Always be careful to perform gas tests in well-ventilated areas.

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

Connecting and Testing

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 5 V microcontroller, such as a BASIC Stamp® module, would be pretty straight forward and require two I/O pins for detecting the alarm signal and controlling the internal heater.

For a 3.3 V 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 can be found in the object documentation.



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, connects to common ground	0V
TP1	Test Point 1 +	Buffered output of sensor (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 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

The CO Gas Sensor Module uses the MQ-7 gas sensor from Hanwei Electronics. When its internal heating element is activated at 1.4 V the MQ-7 gas sensor responds to CO gas by reducing its resistance in proportion to the amount of CO present in the air exposed to the internal element. On the sensor module this is part of a voltage divider formed by the internal element 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 kΩ resistor providing a TTL-compatible signal to a microcontroller. This output also connects to a red LED on the CO Gas Sensor Module. When the voltage from the MQ-7 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 the CO Gas Sensor Module to detect CO with minimal calibration.

Calibration

The zero gas span adjustment is set via potentiometer R3 and the trip level adjustment is set via potentiometer R4. The procedure for setting these potentiometers is explained below. This procedure assumes that you have the Gas Sensor Module connected to a microcontroller that is controlling the heater as per the datasheet. Example source code is provided for the BASIC Stamp 2 module (page 5) and Propeller chip (see the Propeller Object Exchange, http://obex.parallax.com). 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. Please note that turning the potentiometer clockwise decreases voltage, while turning the potentiometer counter-clockwise increases it.

- √ Prior to powering up the module adjust the screw on potentiometer R3 (Set Point) until R3 measures 200 ohms or as close a possible without going under 200 ohms. The easiest place to measure the resistance of R3 using your meter is the pads of R2, which is unpopulated. These pads are just to the left of R3. This adjustment is made during factory testing and is most likely already adjusted for you. It is often easier to test for and make this adjustment with the module out of circuit.
- √ Place the Gas Sensor Module in a clean air environment and supply power to the module. Allow at least 10 minutes before making adjustments.
- √ Adjust the screw on potentiometer R4 (Trip Level) until the voltage across TP3 (+) and TP4 (-) reads between 0.70 V to 0.80 V.
- √ Apply a carbon monoxide (CO) gas/air mixture to the top of the screen sensor face. The voltage across TP1 (+) and TP2 (-) should exceed 0.70 V, the red LED should be lit and the ALR output should be high (5 V). If the red LED does not light it will be necessary to set potentiometer R4 (Trip Level) to a lower voltage where the red LED does light.
- √ Remove the carbon monoxide from the environment and allow the Gas Sensor Module to sit in the clean air for 10 minutes.
- √ Check the voltage across TP1 (+) and TP2 (-) and be sure it is between 0.10 V and 0.20 V, and adjust R3 as necessary. This adjustment may have to be done several times initially.

The above settings should provide a span of ~200 ppm of CO. The use of a standard butane hair curler is an easy, safe source to use for a very low carbon monoxide gas concentration less than 500 ppm and can be used during calibration and testing.

Sensitivity

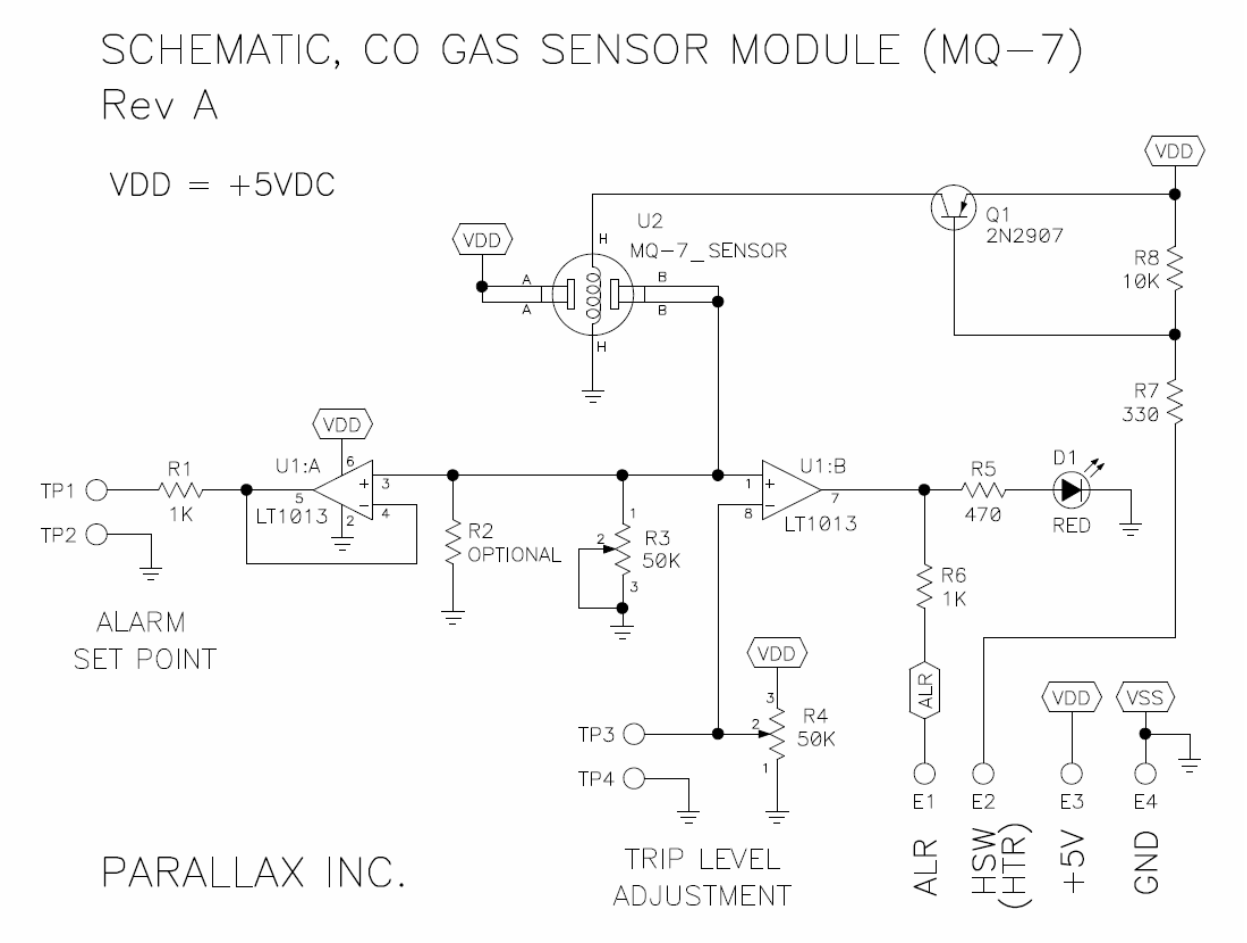
Potentiometer R3 (Set Point) directly affects sensitivity as well as stability to some degree. Adjusting R3 for lower voltages across TP1 (+) and TP2 (-) will decrease sensitivity some while increasing stability. Too low of a setting will cause the sensor to be unresponsive to CO gas. The settings recommended above in the calibration section should work for most applications.

Resources and Downloads

You may download free example programs, the manufacturer datasheet, etc. from the 27931 product page on our website.

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

Schematic



*R2/Optional is a remnant from the original prototype and can be ignored since it is not installed.

BASIC Stamp® 2 Example Program

```
' ================================================================================
'   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                                  ' Of Iterations On BS2
      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                 ' Decrement Counter
      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
```