Analogue Evaluation Board for p-Type Metal Oxide Sensors

1 Introduction and specification

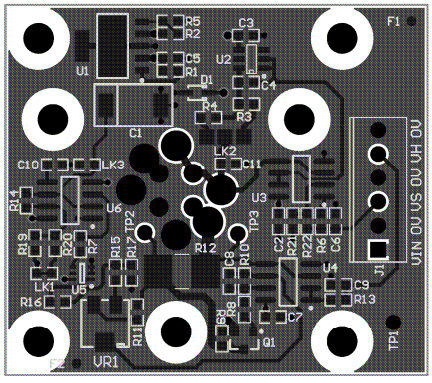
This Evaluation Board measures the sensor signal and controls the heater for a p-type metal oxide gas sensor. This Evaluation Board includes:

- Buffered voltage outputs for heater voltage and sensor resistance measurement
- Integrated two-temperature heater pulsing for optimum sensor performance
- Selectable sensor resistance ranges for low and high gas concentrations

Please read these instructions to ensure correct installation and use of your p-type metal oxide gas sensor.

Gas/ vapours detected	H_2S, VOCs and CO
Sensor type	Alphasense p-type metal oxide gas sensor
Performance	See H_2S, VOC and CO web technical datasheets
Warm-up time	10 minutes to full specification; 30 seconds to reading
Power input	5-6 VDC Transient current: 700 mA (~10s) Operating current: 200 mA
Voltage output	0 to 4.75 VDC
Connector	6-pin Molex plug Pin 1 (power) Pin 2 (supply ground) Pin 3 (sensor signal) Pin 4 (signal ground) Pin 5 (heater power) Pin 6 (heater ground)
Sensor power select (sensor resistance range)	Selectable (LK2) low range (up to 1MΩ) high range (up to 3MΩ)
Heater two-temp control	User selectable (LK3)
Two-temperature pulsing period	User selectable (LK1) 5 minute measurement cycle, 60 second clean cycle 10 minute measurement cycle, 60 second clean cycle
Heater adjustment	10-turn potentiometer to set heater resistance (VR1)
Usage/storage range	-30 to +50 °C (-22 to +122 °F)
Usage humidity	0% to 95% (non-condensing)

Table 1. p-type metal oxide Transmitter Specification



Component	Description
J1	6 way Molex connector
LK1	Two-temperature pulse period select
LK2	Resistance range select
LK3	Single temperature select
VR1	10-turn pot for heater resistance

Table 2. Component description for p-type metal oxide Analogue Evaluation Board and PCB layout.

2 Sensor Operation

2.1 Connection and Wiring

The Evaluation Board is supplied with a 6-pin Molex socket (2.54 mm pitch) for power and signal measurement.

Table 3 below lists pin connections for this connector.

Pin No.	Label	Description
1	VIN	Power supply
2	0V	Ground connection*
3	VS	Sensor output voltage
4	0V	Ground connection*
5	VH	Heater output voltage
6	0V	Ground connection*

Table 3. Pin connections for J1

***Note:** All ground connections are common on the board.

2.2 Power Supply

Your power supply must be between 5 and 6 V DC with less than 1 mV rms ripple. Voltages in excess of 6 V DC will fail the Evaluation Board. Although there is an on-board regulator, it is good practice to minimise noise pickup in your power cable. Check your power cable for noise and ripple.

Do not supply mains AC power to this unit: this will destroy the Evaluation Board and void the warranty.

The Evaluation Board is protected against incorrect polarity and overvoltage and will not function if you have reversed the power supply.

The surge/turn-on current of the transmitter board may reach a maximum of 700 mA. However, in normal operation the required current should not exceed 200 mA (set by the sensor characteristics).

2.3 Operating Temperature Adjustment

The p-type metal oxide Evaluation Board has been designed to get the best performance from the Alphasense metal oxide sensors. The performance of the sensor is strongly dependent on its temperature. The heater circuit uses a constant resistance/ temperature circuit, which allows the sensor to work over a large ambient temperature range.

2.3.1 Quick Setup

For an initial/ quick setup, we recommend the following steps:

1. With the sensor disconnected from the circuit, measure the heater resistance (R_0) of the sensor. The connections for the heater can be found on the relevant sensor datasheet. If possible, the ambient temperature should be close to 20^{o}C, which will give you a measured heater resistance of around 10 Ω.

2. Calculate the heater voltage (V_H) for normal operating conditions using the equation:

$$V_H = 0.144 * R_0 + 1.362$$

3. Fit the sensor and power the circuit. Adjust VR1 until you achieve the expected heater voltage (calculated in step 2) between Pin No. 5 and 6 of J1. It is likely that a number of adjustments to VR1 will be required to set the operating voltage. This is due to the heater resistance varying as the sensor reaches thermal equilibrium.

Please note that for long-term testing, Alphasense recommends using a more precise temperature setting configuration (Ref. to Section 2.3.2)

2.3.2 Precise Setup

Follow these steps to precisely setup the heater for optimum performance:

1. With the sensor disconnected from the circuit, measure the heater resistance (R_0) of the sensor. The connections for the heater can be found on the relevant sensor datasheet. If possible, the ambient temperature should be close to 20 ^oC, which will give you a measured heater resistance of around 10 Ω.

2. Calculate the heater resistance (R_H) at 400^oC, using the equation:

$$R_H = R_0 + R_0 * \alpha * (T - T_0)$$

   where R_0 is the measured initial resistance of the heater, T is the target sensing temperature 400 ^oC, T_0 is the initial temperature 20^oC (or the temperature at which you measured R_0), and α is the temperature coefficient of resistance, which is 3.6 x 10^{-3} /K.

3. With the sensor not in circuit, measure accurately the resistance of R12 (nominally 2.2 Ω).

4. Fit the sensor and power the circuit. Measure the voltages between test points TP2 and TP3 (V_{23}) and TP2 and TP1 (V_{21}) as shown in the board diagram. Adjust VR1 until you achieve the expected heater resistance (calculated in step 2). You must measure V_{23} and V_{31} throughout this process. The heater resistance (R_H) and these variables is given by:

$$R_H = R12 \times (V_{21} / V_{23})$$

Note: Depending on the ambient conditions, we recommend that you re-check the heater resistance 10 minutes after its initial setup. Also, the setup process should only be undertaken during a "measurement cycle" and not during a "clean cycle" (Ref. to Section 2.4).

2.4 Temperature Pulsing

Alphasense recommends the use of two-temperature pulsing to provide the best performance from the p-type metal oxide sensors. Once the correct heater resistance has been set, the Evaluation Board will switch automatically between the "measurement cycle" and "clean cycle" (more details can be found in ANN601 Application Note).

The Evaluation Board can be set up with two different two-temperature pulsing time periods. The default (as the board is supplied) is a 5 minute measurement cycle, followed by a 1 minute clean cycle. However, this ratio can be changed to a 10 minute measurement cycle with a 1 minute clean cycle by removing the solder link LK1.

The heater voltage can be monitored via pin 5 of J1. The heater voltage will not exceed 4.75 V. In normal operation, the heater voltage in a measurement cycle should be typically between 2.7 V and 3.7 V. in a clean cycle More details on the heater voltage range can be found on the individual metal oxide sensor datasheets.

The two-temperature pulsing can be disabled by soldering a link on LK3. Once disabled, the sensor will operate at a single temperature. However, the board should still be setup as described in section 2.3. Alphasense does not recommend the use of single temperature operation.

IMPORTANT: When the sensor is in a clean cycle it will not detect the target gas. The sensor can only detect target gases during the measurement cycle.

2.5 Sensor resistance range setup

The Evaluation Board uses a constant current sensor drive, allowing the sensor resistance to be measured as a simple voltage output. The Alphasense Evaluation Board provides a voltage that is linear with sensor resistance.

The Evaluation Board can be selected for two different resistance ranges:

- Max 3.5 MΩ for high gas concentrations
- Max 1 MΩ for low gas concentrations

This resistance range is selected using LK2. To change to the higher gas concentration range (from the default of low range): remove the solder link and re-solder the central pin of LK2 to the alternate pad (near R3).

The sensor resistance can be monitored on pin 3 of J1. The output voltage will not exceed 4.75 V in normal operation. The sensor resistance can be calculated using a linear regression equation:

$$\text{Sensor Resistance } (\Omega) = \beta * V_{out}\,(\text{mV})$$

Parameter	Low resistance range	High resistance range
β	230	650

Table 4: Resistance conversion table.

For best performance, we recommend the use of a high impedance measurement circuit or ADC. A buffer may be required for your recording/ logging circuit.

Note: A new p-type metal oxide sensor (all variants) will have a higher sensor resistance when first powered. Alphasense recommends a burn-in period of two hours before being calibrated using a reference gas. In addition, we recommend stabilisation and recalibration if the sensor has been powered off for a significant period of time.

3 Replacement/ additional parts ordering

Replacement and spare parts can be ordered by quoting the part numbers below.

Part Number	Description
034-0025-00	M6 Nylon washer
010-0178-02	ISB Transmitter Lead
029-0059-00	Foam Seal 'A' Series 4-20mA Gas Hood (For use with TO5 Gas Hood)
029-0068-00	Foam Seal (For use with ATEX & 6 Pin Plastic Gas Hood)
033-0012-00	M3x20mm long Pillar (Individual part number).
000-GSHD-08	MOX Evaluation Gas Hood Assembly for MOX ATEX
000-GSHD-09	MOX Evaluation Gas Hood Assembly for MOX 6 Pin Plastic
000-GSHD-10	MOX Evaluation Gas Hood Assembly for MOX TO5
H_S2, VOC and CO (all packages)	Replacement sensor. Heater recalibration will be required.

Table 5. Replacement/extra parts for metal-oxide transmitter.

4 Troubleshooting

Below table lists the required actions if you have any problems with your transmitter.

Problem	Action
No output signals	Check the supply is being provided to the right pins and that the input voltage is between 5 and 6V.
Heater voltage output out of range	Re-measure the heater resistance at room temperature and re-calculate heater resistance for 400 ^{o}C. Allow the sensor to stabilise for longer before re-checking heater resistance.
Sensor voltage out of range	Check the sensor is correctly connected and in the correct orientation. Check that the heater resistance has been correctly set up.
Output voltage is below expected levels.	Check the input impedance of your measurement circuit.
Power correct, but no sensor/heater output.	Contact Alphasense for assistance.

Table 6. Troubleshooting guide for metal oxide transmitter.

5 Warranty and support

p-type metal oxide sensors are warranted for two years.

If you have any difficulties, questions or problems, then please contact us