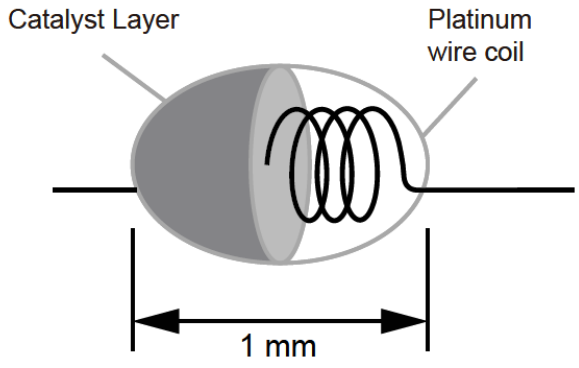
LEL Combustible Sensors

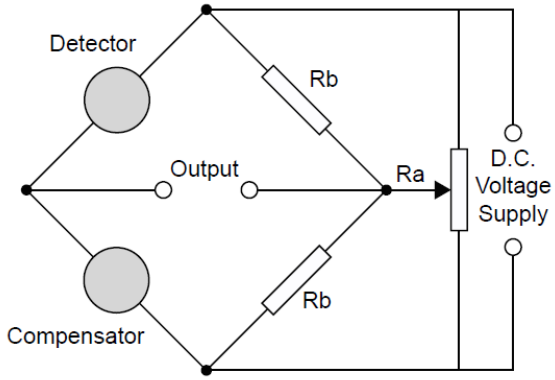
1. Working Principle:

LEL gas sensors consist of a pair of very small elements called "beads" and these are included in the explosion-proof enclosure. One of the beads serves as detector, made of one electrically heated platinum coil covered by two layers of substance. The inner layer is ceramic matrix and outer layer is catalyst. The other bead is compensator, similar to detector but without catalyst layer. Both elements are positioned on two branches on the same side of Wheatstone bridge circuit. The detector catalytically oxidizes flammable gases, while the compensator does not react to these gases and just compensates for external temperature or humidity changes. Heat could be released due to the catalytic oxidation reaction (COR). The energy generated causes a change in the resistance of the catalytic bead, while the reference bead maintains a stable resistance. The change of resistance is measured by Wheatstone bridge circuit, indicating the presence of LEL combustible gas.

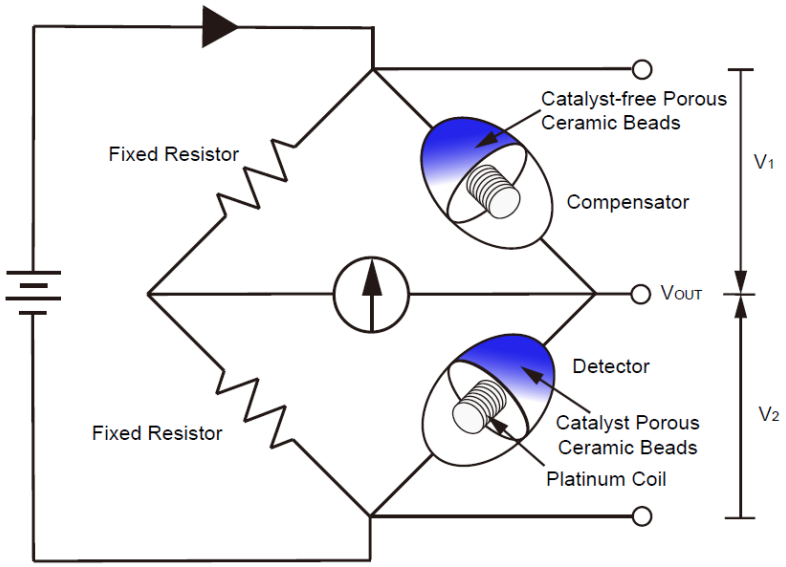
During operation, a current is passed through to platinum coil, maintaining the element temperature at approximately 450 to 500°C. Upon exposure to combustible gases, the detector undergoes a catalytic combustion reaction, causing the temperature of the platinum coil to rise, along with its resistance increase. The concentration of the sample gas can be accurately calculated by measuring the resistance changes in Wheatstone bridge circuit.



Catalytic Gas Sensor Schematic diagram



Suggested Operating Circuit



2. Specifications:

- **Sensitivity:** The sensitivity of gas sensor typically refers to the ratio of change in output value variable (electrical signal) to change in the measured input variable (gas concentration). For LEL combustible sensors, this most common unit is mV/% CH4 LEL combustible gas sensors are capable of detecting various flammable gases so that they cannot distinguish between different types of flammable gas, which means that users may hope to modify calibration gas according to their particular application. Moreover, LEL combustible sensors can be equipped with filters to prevent catalyst inactivation due to poisoning. Although these filters can prevent harmful gases from damaging catalysts, they also restrict the mobility of large hydrocarbons (those with more than 6 carbon atoms). This means that LEL combustible sensors with filter have poor responsiveness to large hydrocarbons.

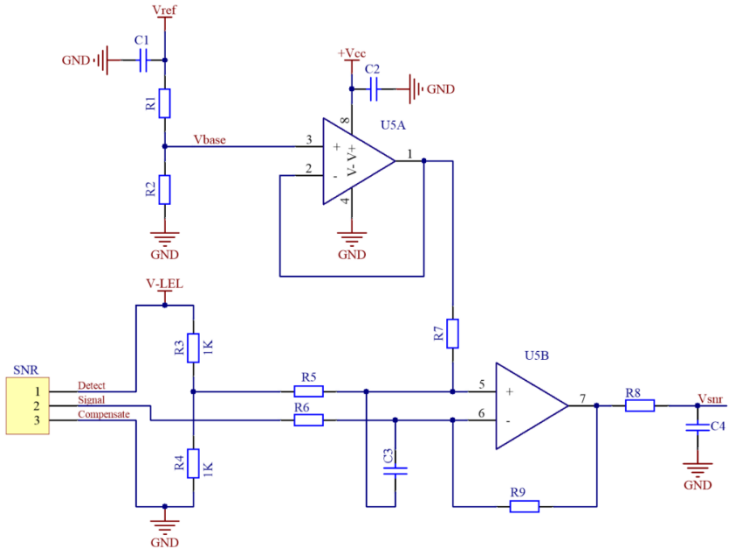
- **Response Time:** Response time represents the speed at which a gas sensor responds to the gas being detected. It can be also described by the time needed for a sensor's output to change by a specified percentage (typically 90%) of its stabilized value following a sudden step change in gas concentration.

- **Stability:** The stability of gas sensors refers to their ability to maintain a consistent output that does not deviate beyond the allowable error under specified operating conditions and over a certain period. This indicates the sensor's resistance to factors other than gas concentration.

- **Baseline:** The output value of gas sensors in clean air or reference gases under specified operating conditions.

- **Resolution:** A measure of the smallest separation between two adjacent target gas concentration points that can be detected by the gas sensor.

3. Recommended Schematic:



When sensors operate in clean air, the output signal (Vsnr) is equal to the baseline signal (Vbase).

If sensors have detected target gases, the resistance of detector increases, causing the Vsnr signal voltage to rise.

4. Transportation and Storage:

SemeaTech LEL combustible gas sensors belong to non-hazardous goods and are not required to be transported in specialized package or label. The sensors should be stored in special sealed boxes that should only be opened when needed for use.

5. Precautions for Use:

The performance of LEL combustible sensor is affected by the following factor:

Poisoning: Contaminant compounds such as lead, silicones, phosphates and sulphur-containing compounds will be decomposed on contact with catalyst and form a solid coating on the surface, which will reduce the sensitivity of sensors and may even result in complete sensor failure. The common product containing those compounds include haircare products, lotions, cleansers and degreasers. Poisoning occurs gradually, but LEL combustible sensors may expire after one accident exposure to some extreme circumstance. Whether poisoning has happened or not can only be identified by ventilation test or recalibration.

Temporary Suppression: Pollutant compounds such as Volatile Organic Compound (VOC) and hydrogen sulfide (H2S) can be absorbed by the catalyst. These compounds will absorb to the catalyst active site, inhibiting the catalytic reaction and leading to temporary loss of sensitivity. This temporary suppression can be reversed by exposing the sensors to clean air for a period of time, allowing them to recover sensitivity.

Overload: When the LEL combustible gas sensors are exposed to too high concentration flammable gases, for example: When Methane (CH4) concentration is above 8 % vol, LEL combustible sensors' performance will be affected in the following phenomenon:

- Sensors may show significant drift from baseline zero value
- Sensors may loss sensitivity and fail to accurately measure gas concentration values.
- Catalyst bead installed in LEL sensors may be permanently damaged and then sensors can't detect gases anymore. LEL combustible sensors must be recalibrated after exposed to high concentration gases in case that sensors are fully functional before further use.

Low Oxygen Concentration Environment: LEL combustible sensors require sufficient oxygen levels to provide accurate gas concentration readings, as their operating principle is by burning flammable gases. When oxygen concentration falls below 10% by volume, complete combustion is no longer possible. In such circumstances, the catalytic bead may become contaminated with soot, leading to permanent loss of sensitivity.

Mechanical Breakage: LEL combustible sensors use a fine platinum wire embedded in a bead as a heat source. Mechanical force, the heat added to the beads, as well as exposure to industrial chemicals, can disrupt the tight contact between the platinum wire and the bead surface, leading to potential failure. If damaged, sensors will not operate anymore.

Environmental Conditions: Temperature, humidity and pressure don't have significant effect on resolution of LEL combustible sensors.

6. Special Reminders:

Maintenance: LEL combustible sensors should be protected from known pollutant aggression. To ensure the safe operation, it is recommended to periodically conduct ventilation tests and calibrate. If the sensors have been exposed to known pollutants or damaged, these procedures should be carried out immediately. Please replace the LEL combustible sensors at once when the ventilation test and recalibration indicate that the sensor's performance has been compromised.

Important Information: Follow proper guidelines for ventilation testing and calibration. For instance, do not use a butane cigarette lighter to test the response of LEL sensors because it will cause long-term damage to the sensors.

Calibration Gas Selection: SemeaTech LEL combustible gas sensors are calibrated with 50% LEL Methane. If detection of other gas types is required, please perform zero calibration using the appropriate calibration gas.