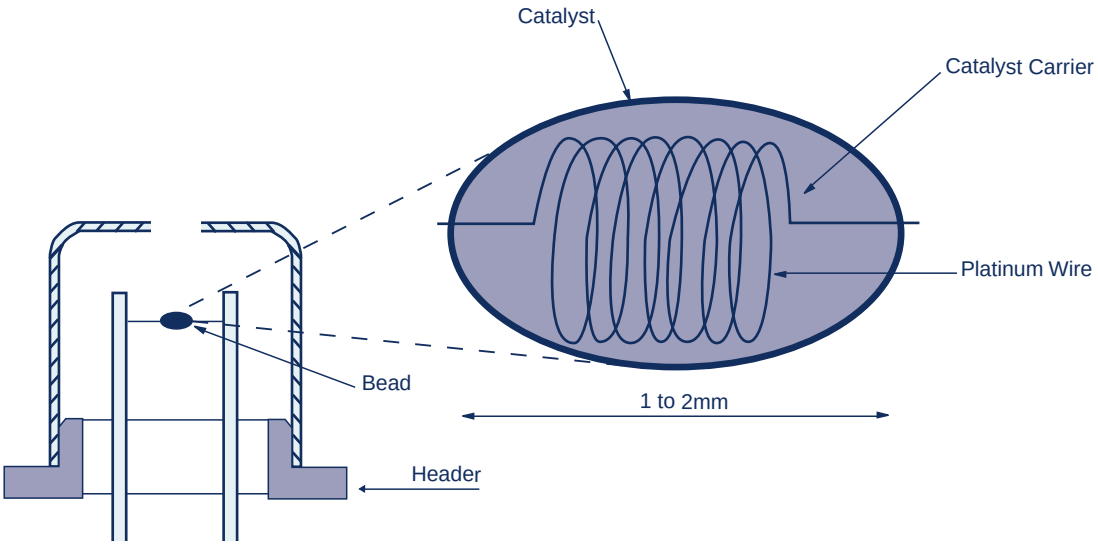
2.1 Principles

Sixth Sense gas sensors for combustible gases work on the principle of catalytic oxidation and are commonly referred to as pellistors. They are designed to detect the presence of most combustible gases below 100% Lower Explosive Limit (LEL). To detect combustible gases up to 100% v/v it is necessary to use a thermal conductivity sensor (see product data sheet TC2).

A pellistor element is simply a platinum wire coil, coated with a catalytic slurry of an inert base material (e.g. alumina) and a metal catalyst which accelerates the oxidation reaction. This type of element is known as the "sensitive" element. There are a number of catalyst materials available and the precise type and mix is carefully chosen to optimise sensor performance. Figure 1 shows a cross-section of a typical catalytic element.

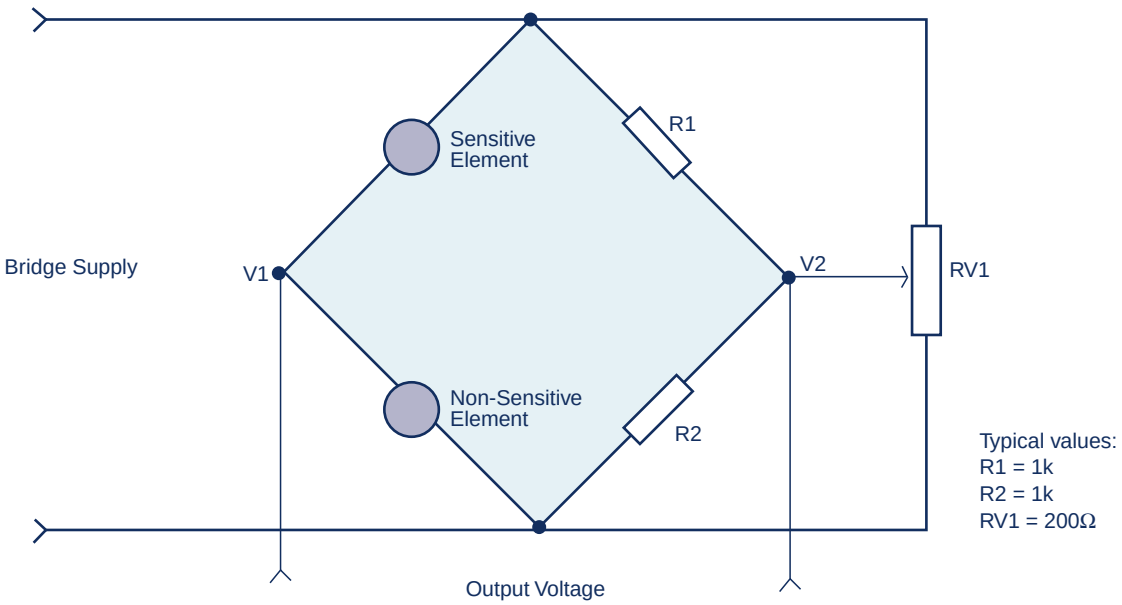
Figure 1 Cross Section of a Catalytic Element



In addition to the sensitive element, a "non-sensitive" element is manufactured. There are two types of non-sensitive element. The first is used primarily in high power devices and for this the catalytic slurry is replaced with glass which will not oxidise combustible gases. The second type is used for low power devices. This type of non-sensitive element starts life as a sensitive element and as such is manufactured in exactly the same way. However, to prevent oxidation the catalyst is "poisoned" during production using a suitable substance such as potassium hydroxide.

In operation, a pair of beads is always used and this pair comprises a sensitive and a corresponding non-sensitive element. During manufacture, individual pairs are closely matched by voltage and current requirements and therefore do not need any compensation (i.e. a trimming resistor) when used in equipment. This pair of elements is then installed into a "Wheatstone Bridge" as illustrated in Figure 2, which heats them to between 400 and 500°C. When no gas is present the resistances of the two elements are balanced and the bridge will produce a stable baseline signal. Combustible gases are then oxidised on the sensitive element, causing its temperature to rise. Accordingly the resistance of the element also increases. This results in an "out-of-balance" signal across the bridge and a corresponding change in output voltage which can be easily measured.

Figure 2 Typical Wheatstone Bridge Configuration



The Bridge Supply is typically 2.0 to 3.5 volts, depending on the sensor. Voltage V1 is set by the potential divider of the sensitive and non-sensitive elements and when no gas is present, this is nominally half the bridge supply voltage. Voltage V2 is also half the bridge supply and is predominantly determined by the potential divider of R1 and R2. RV1 is used to fine tune V1 and V2 so that they are the same value when no gas is present and enables the bridge output to be set to zero.

When gas is present, the resistance of the sensitive element rises, causing V1 to decrease and the output, being the difference between V1 and V2, also rises. The function of the non-sensitive element is to eliminate any effects that environmental conditions may have on the resistance of the two elements. Any changes will be the same for both the sensitive and non-sensitive elements and so the bridge voltage V1 and output voltage remain unchanged.

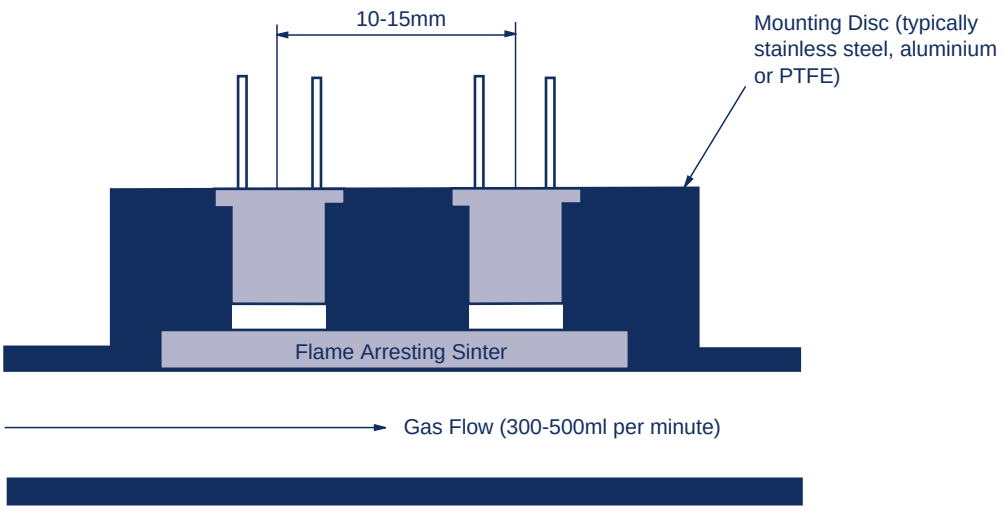
2.2 Bridge Supply

Sixth Sense sensors are optimised for either use at a constant voltage or a constant current. Constant current is predominantly used in high power fixed systems and ensures that the elements are correctly powered, even if the power source is a number of meters away. Where battery life is a concern, constant voltage is preferred and as such, all low power elements are optimised for constant voltage.

2.3 Housing Options

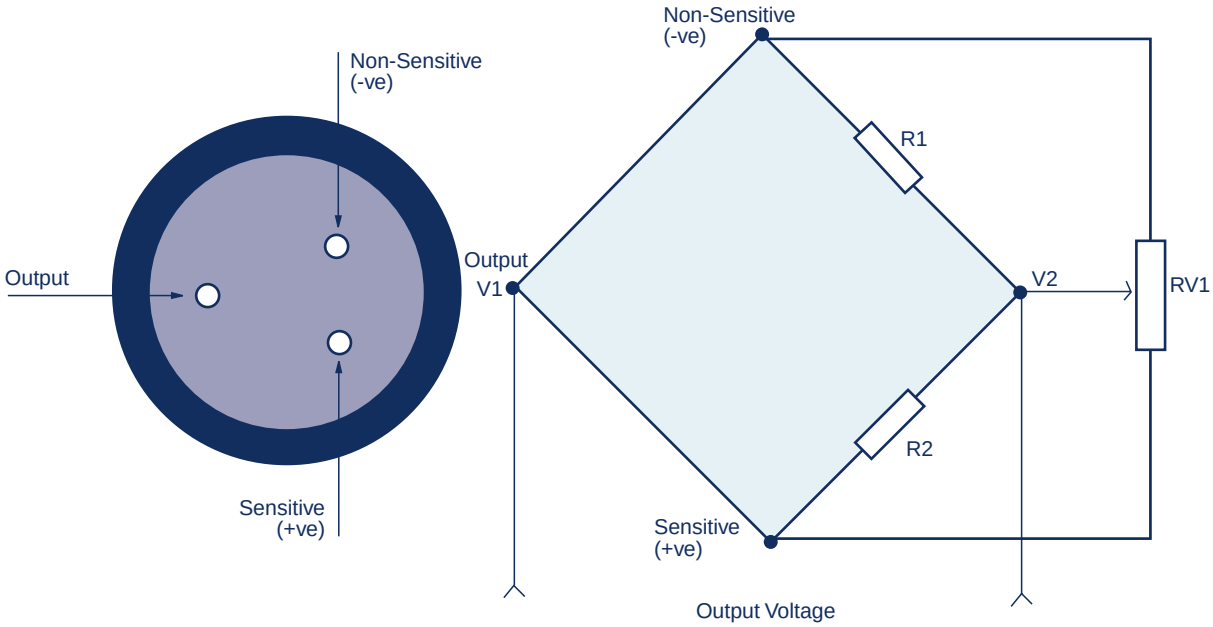
All Sixth Sense pellistors are available as matched pairs of individual elements for incorporation into sensing heads. They can be used in both diffusion or sample stream systems, although it is important to ensure that flow rates in sampling systems are controlled so as not to adversely affect performance. The recommended mounting configurations for both sampling and diffusion use are shown in Figure 3.

Figure 3 Recommended Mounting Configurations



Low power elements, suitable for use in battery operated devices, are available either as individual elements or as a matched pair housed in a stainless steel sensor with integral flame arresting sinter. There are two types available with either three or four output pins. The three pin version is designed to compliment the MIDI range of toxic gas sensors and in this configuration, the two elements are linked so that the three pins form three of the four corners of the Wheatstone Bridge. This is shown in Figure 4.

Figure 4 Modified Wheatstone Bridge for 3-pin Sensors



All sensor housings from Sixth Sense are suitable for use in certified equipment and where possible component certification will be provided. Details of applicable certifications are included on relevant data sheets.

For special mounting, housing or certification requirements, please contact Sixth Sense.

2.4 Poisons and Inhibitors

Some substances and vapours can reduce the sensitivity of catalytic sensors. Catalysts rely on the presence of "active sites" where molecules are brought together in an environment that is ideally suited for the desired reaction to take place. If these sites become blocked by other materials, then the required reaction cannot occur and therefore as the percentage of blocked sites increases, so the sensitivity of a catalytic element decreases. There are two types of substance that can affect catalytic sensors:

Poisons - These are compounds that permanently affect the performance of the sensor. They can either directly coat the catalyst or react on the surface on the catalyst, creating compounds which create a solid barrier. In both cases, the effect is cumulative and permanent. The most common poison is silicone and silicone containing substances. It is therefore extremely important that manufacturing areas where catalytic sensors are being used are kept clean and free from poisons - remember, many cleaning fluids, sprays and hand creams contain silicone so these should always be avoided.

Inhibitors - These compounds act in a very similar way to poisons except that the reaction is reversible and the sensor will recover to full sensitivity after exposure to clean air. Typical substances include hydrogen sulphide and halogenated compounds.

Whilst it is currently impossible to eliminate these characteristics altogether, their severity can be significantly reduced. Correct catalyst selection and subsequent application is critical in minimising the effects of poisoning substances and Sixth Sense sensors are well renowned for being the most poison resistant available. If necessary, active filters can be used in conjunction with Sixth Sense products and details of suitable materials are available upon request.

The characteristics of individual products are detailed on the corresponding data sheets and further details can be provided by Sixth Sense.

2.5 Calibration

Catalytic sensors will oxidise most combustible vapours and as such offer a true "explosimeter". Their sensitivity to different substances varies, depending on the combustibility of the substance. The sensitivity of a catalytic sensor is defined as its relative sensitivity to methane and each product data sheet details this information. As a general rule, it is important to identify which substances are most likely to be present and to set the sensitivity of the finished detector in accordance with the substance that has the lowest relative sensitivity. This will ensure a fail-safe device.

It is important to remember that the relative sensitivity data given is a guide and products should always be calibrated using the target gas. Please also note that LEL figures for individual gases can vary from country to country and can change as more up to date information becomes available. Please refer to your relevant legislative organisation or contact SixthSense before designing new products.

Sixth Sense catalytic sensors are designed to be extremely stable over very long periods of time. As such it is possible to significantly reduce the amount of in-field calibration that is required. However, since external factors such as poisons and mechanical shock, can affect sensor performance we recommend that the interval between calibrations is no longer than 6 months.

2.6 Testing

All combustible gas sensors from Sixth Sense are individually tested with methane prior to delivery. Using a unique computerised testing system, all test parameters are recorded during the test cycle and recorded against the corresponding serial and batch numbers. For further details about the test procedure or to arrange for test results to be sent with your sensors, please contact Sixth Sense.

2.7 Identification and Packaging

All catalytic sensors from Sixth Sense are marked to identify if they are sensitive or non-sensitive and are individually identified by part number, serial number and the batch/date code. If required, further information can be added upon request, such as sensor output or your company name. For specific labelling requirements, please contact Sixth Sense for advice.

Our gas sensors are packaged in sealed containers to protect them from the stresses of transportation and environmental conditions. We recommend that they are stored in their original packaging to maximise their operating life. For shipments of individual sensors, each sensor will be packed into sealed containers which are also labelled as detailed above. For bulk shipments, they are bulk packed accordingly.

For more specific details on packaging or to arrange an alternative method, please contact Sixth Sense.