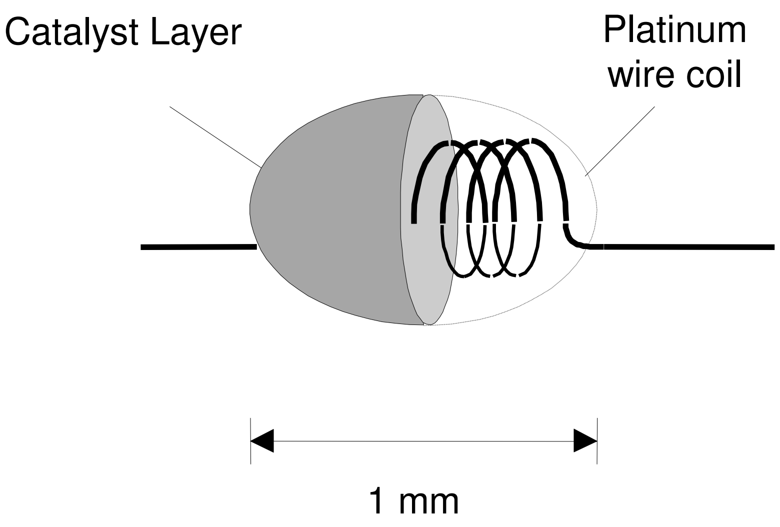
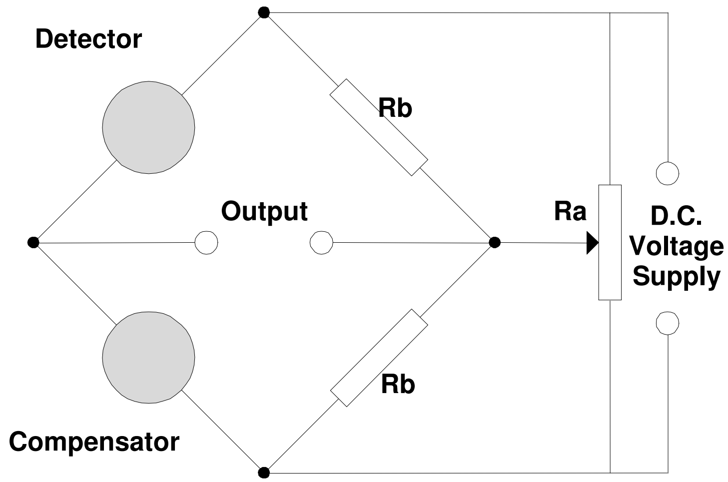
Catalytic sensors

- Physical principle
- The working principle of catalytic sensors is based on flammable gas oxidation: when a combustible gas comes in contact with the catalyst surface it is oxidised. The reaction releases heat, which causes the resistance of the wire to change.
- A catalytic palletised resistor (or “Pellistor”) consists of a very fine coil of platinum wire, embedded within a ceramic pellet. On the surface of the pellet is a layer of a high surface area noble metal, which, when hot, acts as a catalyst to promote exothermic oxidation of flammable gases.
- In operation, the catalyst layer is heated by passing a current throughout the underlying coil. In the presence of flammable gas the hot catalyst allows oxidation to occur in a similar chemical reaction to combustion.
- Just as in combustion, the reaction releases heat, which causes the temperature of the catalyst together with its underlying pellet and coil to rise. This rise in temperature results in a change in the electrical resistance, which constitutes the signal from the sensor.
- Pellistor sensors are always manufactured in pairs, the active catalysed element being supplied with an electrically matched element which contains no catalyst and is treated to ensure that no gas will oxidise on its surface. This “compensator” element is used as a reference resistance to which the sensor’s signal is compared to remove the effects of environmental factors other than the presence of a flammable gas.

Catalytic sensors



Catalytic Gas Sensor
Schematic diagram



Suggested
Operating Circuit

(doc. NEMOTO JAPAN)

Catalytic sensors

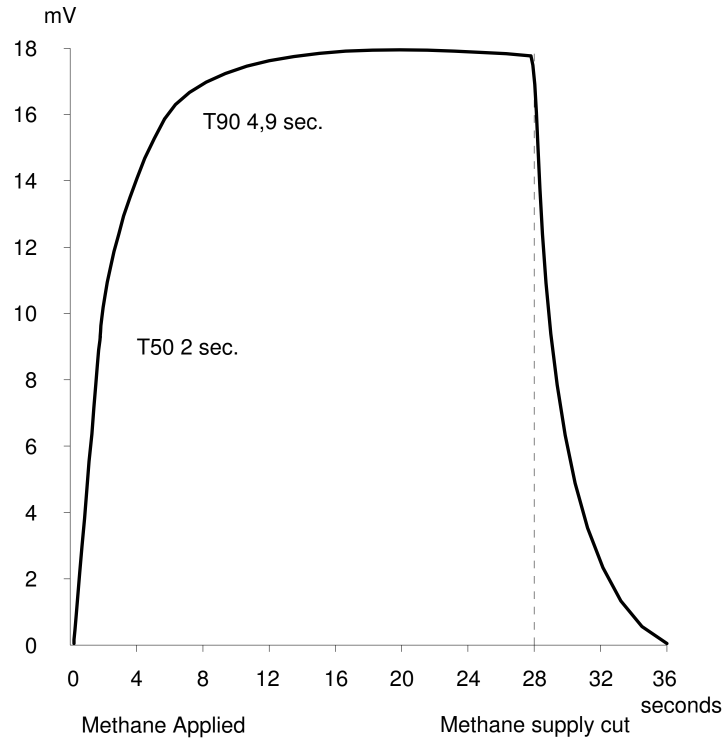
Environmental conditions such as temperature, humidity and pressure variation, influence both of the beads (the active sensor and the reference) therefore the Wheatstone bridge will not be unbalanced. This characteristic makes it possible for the Pellistor to provide for a careful read-out also in critical environmental conditions.

Along with its capability to compensate for variations in the environmental conditions, a professional catalytic sensor offers several benefits: linearity, meant as the linear relationship between zero and the span gas value; repeatability, defined as the percent error between the reading generated by a second application of calibration gas and the first benchmark value, compared to the range; reproducibility, intended as the possibility to get the same value, related to the same concentration and environmental conditions, on more sensors belonging to the same type and manufacturer.

Catalytic sensors - applications

The catalytic sensor is excellent for the detection of a wide range of combustible gases within the Lower Explosive Limit (LEL).
The response time depends on the gas being detected: the greatest is the gas weight or the molecular dimension the longer will be the response time.

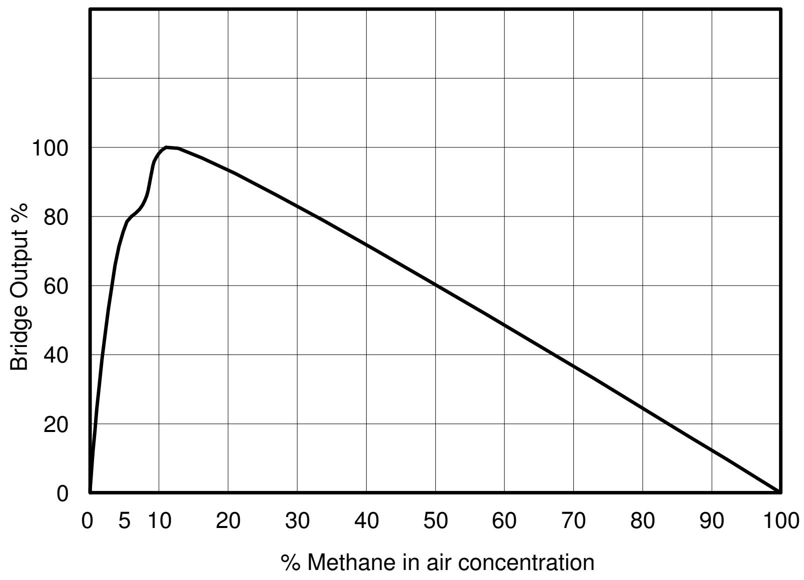
A T90 response to methane detection is usually provided in 5-10 seconds; a slight increase occurs when the sensor is protected by a sintered filter.



(Doc. E2V)

Catalytic sensors - applications

Although the bridge output is substantially linear up to 100% LEL, the use of catalytic sensors is not recommended over that percentage.
Over the LEL values there may be insufficient oxygen to catalyse all of the combustible gas: the output may decrease and indicate a concentration of less than 100% LEL, causing an ambiguity in the instrument readout.

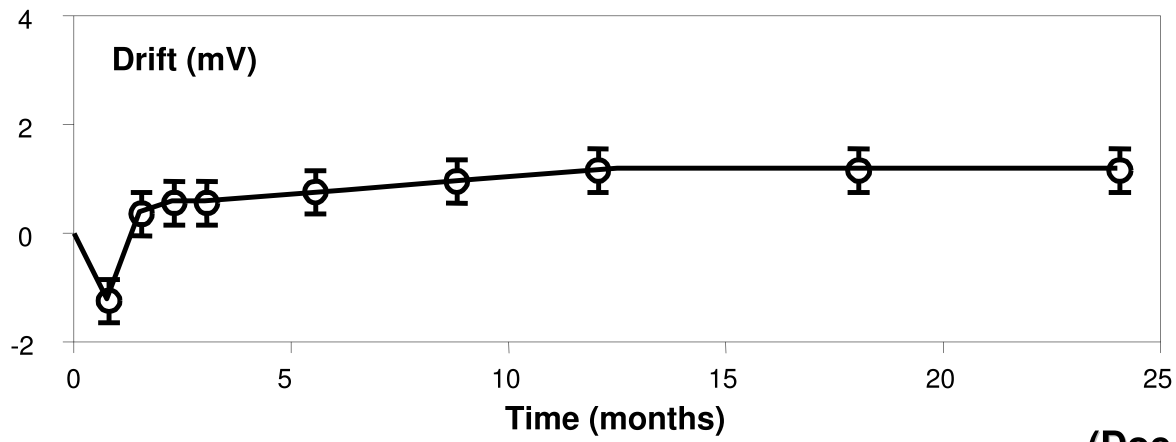


(Doc. E2V)

Catalytic sensors - applications

If Pellistor cells are exposed to a concentration over the highest limit for more than a few minutes, they may be damaged and lose sensitivity. For this reason it is advisable to always use calibration cans for regular maintenance or starting service.

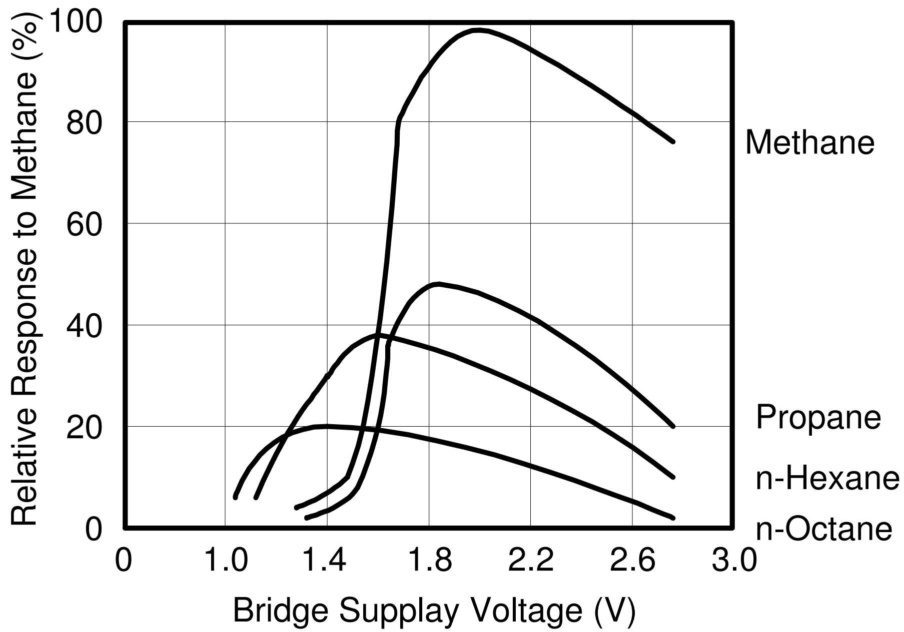
In normal operating conditions Pellistor sensors have an expected lifetime lasting many years (more than 5 years), none-the-less they suffer from sensitivity loss between 5-10% a year, according to the models. For this reason, and according to the directives on force, they must be controlled and adjusted with a periodical maintenance every 3-6 months.



(Doc. Nemoto)

Catalytic sensors - applications

Output variation for the %LEL concentration of different gases is called relative sensitivity. Tests have been made to determine experimental values of relative sensitivity for a wide range of flammable gases, that manufacturers provide with the sensors they produce.



(Doc. E2V)

Catalytic sensors - relative sensitivity

Methane = 1

Gas	Factor	Gas	Factor
Acetone	1.938	n-Heptane	2.593
Acetylene	1.761	n-Hexane	2.718
Ammonia	0.790	Hydrogen	1.305
Benzene	2.456	Methyl Acetate	2.014
Butane	1.710	Methyl Alcholol	1.164
Iso-Butane	1.938	n-Octane	2.673
Iso-Butyl Alcohol	1.892	n-Pentane	2.183
Cyclopropane	1.607	Propane	1.812
Ethane	1.478	n-Propyl Alcohol	2.125
Ethyl Acetate	1.951	Propylene	1.941
Ethyl Alcohol	1.374	Toluene	2.478
Etylene	1.416	m-Xylene	2.557

(Doc. E2V)

Catalytic sensors - restrictions

Catalytic sensor performance may be altered by the presence of some substances. These may be divided into two categories: inhibitors and poisons.

Inhibitors

Inhibitors cause a temporary loss of sensitivity to the sensor. Sensitivity may be partially or totally recovered after a short exposure to fresh air. The most common inhibitors are H_2S, chlorine, chlorinated hydrocarbons and the halogen compounds.

Poisons

Poisoning compounds cause a permanent reduction of the sensor sensitivity thus to damage the sensor completely. Silicon compounds and tetraethyl lead are among the most common poisons.

The presence of inhibitors or poisons is the most common cause of problems in the gas detection and, for this reason, it is necessary to pay attention in order to avoid any contamination.