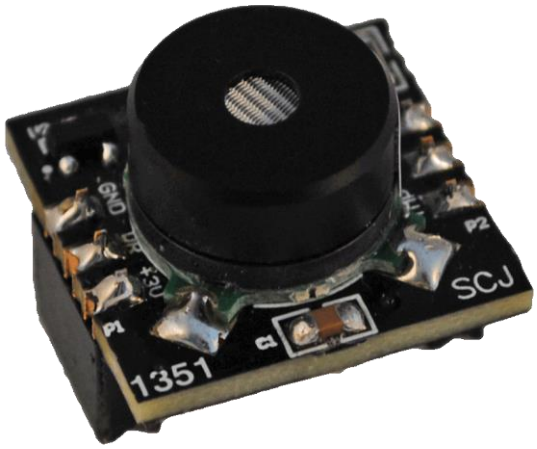
MP-7217-TC Sensor –Build & Operation



The MP-7217 –TC sensor is a combined pellistor and thermal conductivity sensor designed to measure methane in 2 concentration ranges;
0-100% LEL and 0-100% volume.

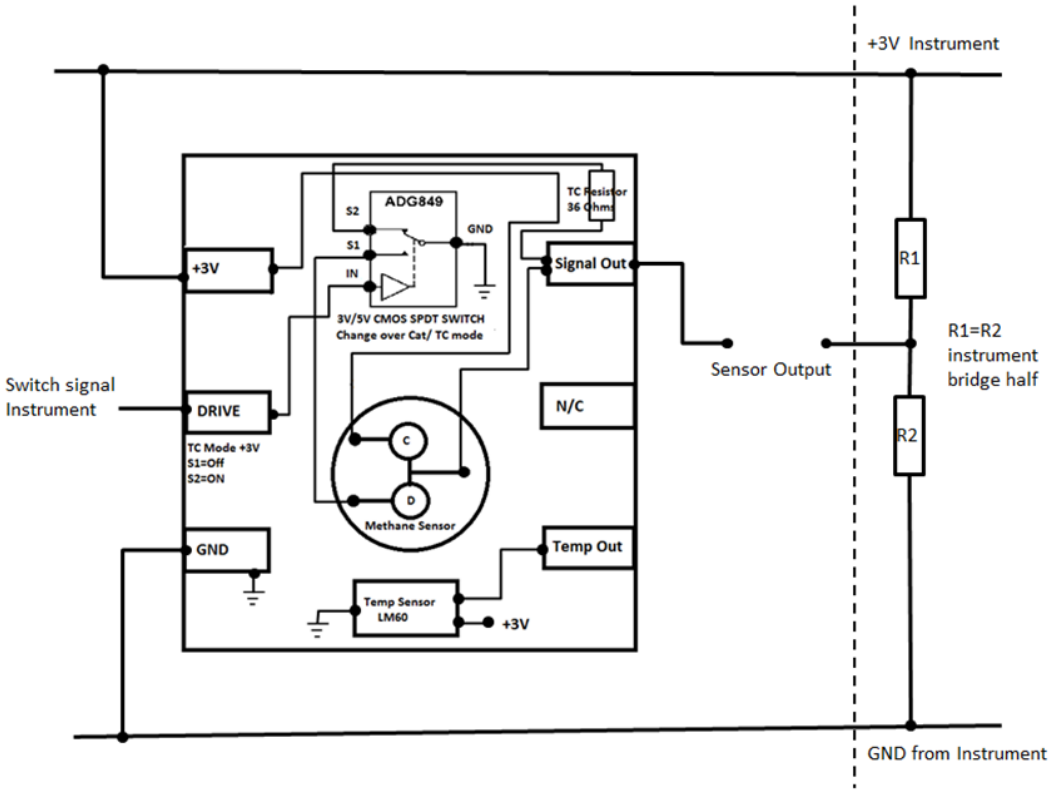
Sensor Build and Operating Principle

The silicon pellistor structure consists of a pair of accurately micro machined diaphragm with two embedded planar heater meanders coated with a layer incorporating a noble metal catalyst for detector bead and with inert layer for compensator bead. The meander acts both as an electrical heater and as a resistance thermometer. The bead is mounted on a PCB with wire bonding and is surrounded by a plastic can with the end open to the atmosphere.
In catalytic mode, if a flammable gas is present when the sensor is operated, the gas will oxidise (burn) on the detector bead and not on the inert compensator bead. This oxidation will result in a release of energy which will heat the detector bead. The increase in the temperature of the detector bead is detected as an increase in resistance and a voltage output when operated in the catalytic mode of the driver circuit.
In thermal conductivity mode, the normal detector or catalytic bead is switched out and unpowered. In its place a high quality SMD resistor is switched into the bridge circuit .The change in resistance of remaining compensator bead when exposed to gases of different thermal conductivity to air is used as a measure of the methane concentration up to 100% volume. As the resistance of the SMD resistor is not affected by temperature, unlike the compensator, the output of the sensor in thermal conductivity mode will change with ambient temperature. To allow for this effect an on board temperature sensor is provided to allow signal compensation in the instrument.

Sensor Operating Circuit and Range Change

The sensor is operated in a Wheatstone bridge type circuit. The sensor operating mode is selected using a switch controlled by a voltage sent to the ADG849 component. If the voltage applied to the switch is between 0 & 0.8Volts, ideally set to ground, then the switch will be 'Low' mode. To select "High" the applied voltage needs to be above 2 volts and up to 3 volts.
The overall circuit is shown below, on the left hand side is the circuit on the sensor, on the right hand side is the other half of the bridge contained within the instrument comprising 2 resistors (with the output at the junction between the two.
With the switch in the "low" mode the current flows through the detector and compensator in "High" mode the current flows through the resistor and the compensator. The supply should be run in constant voltage mode and should be stable to within 5 mV to avoid changes in the zero.

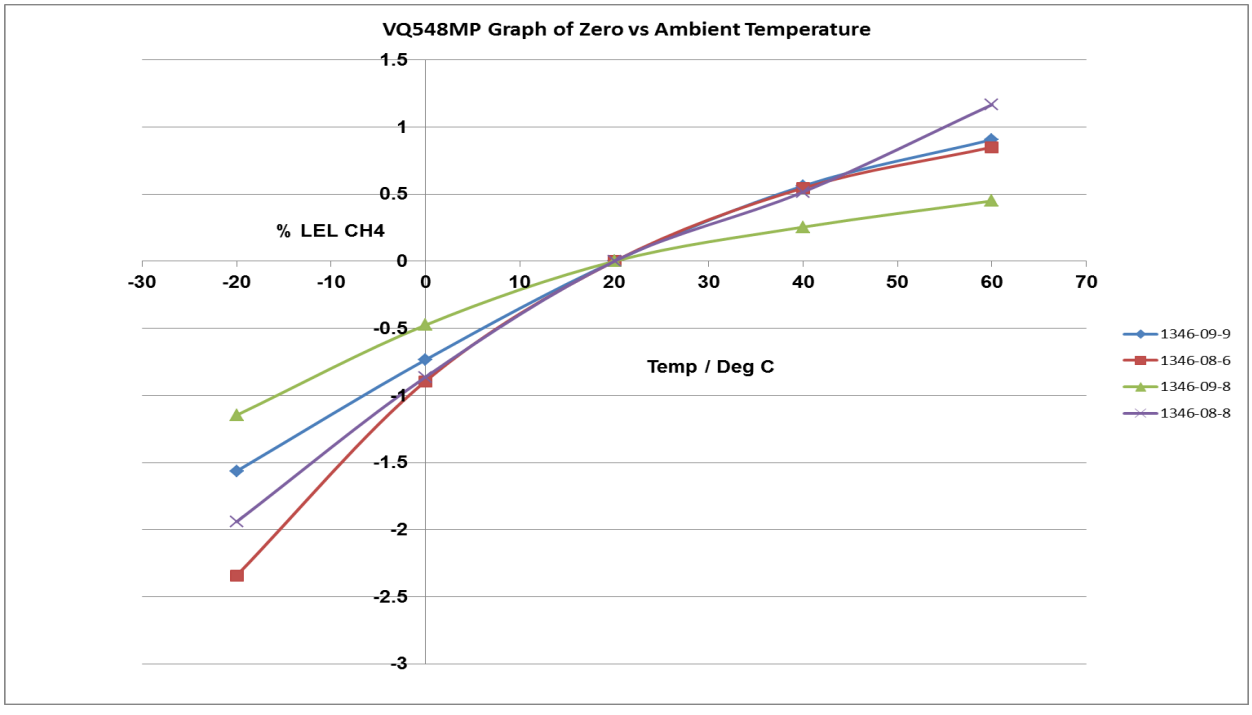
Typical Instrument Configuration

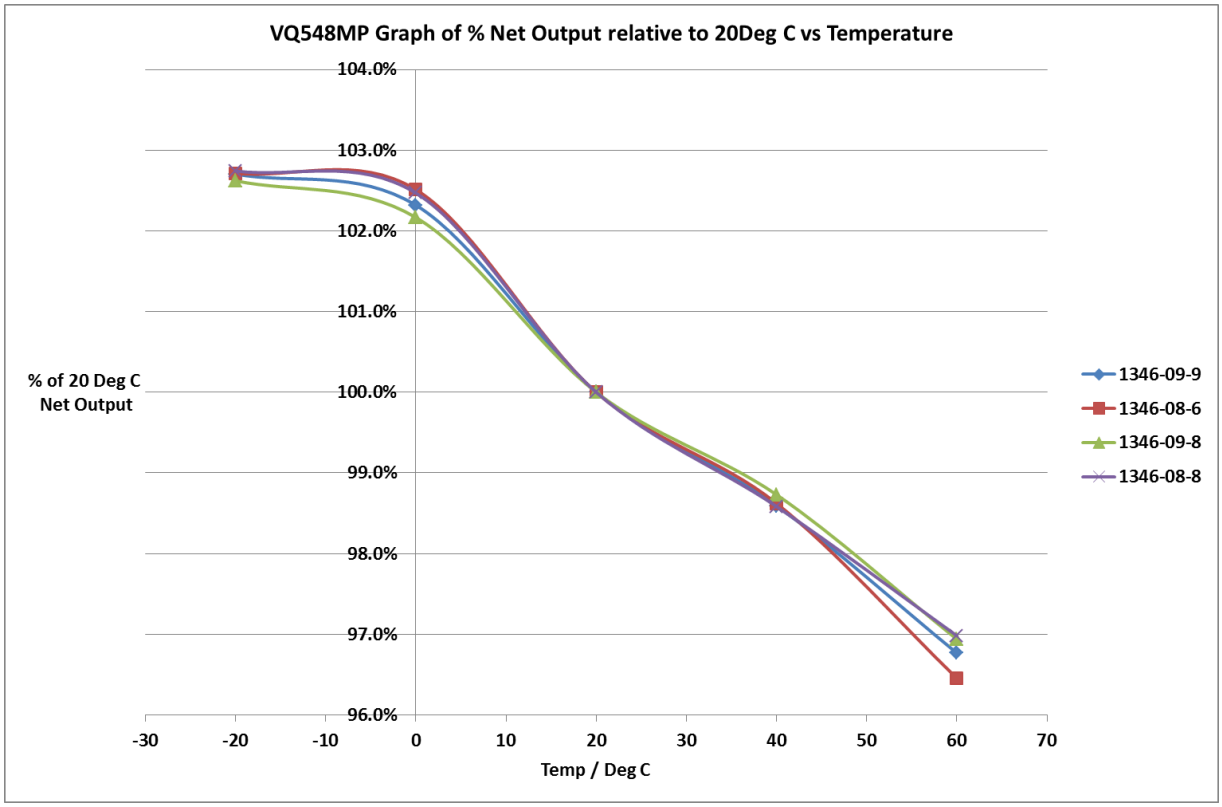


Temperature compensation

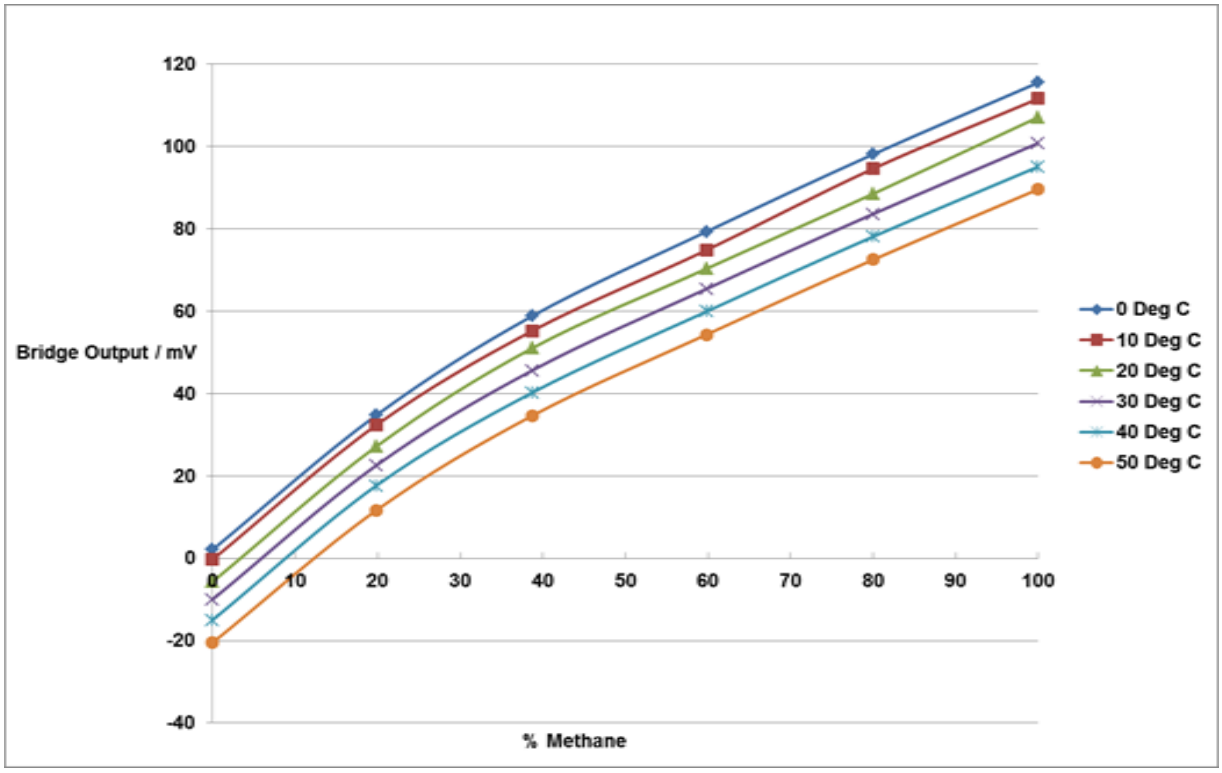
The on-board temperature sensor can be used to carry out temperature compensation of the outputs in Catalytic and TC mode.

In catalytic mode the compensation on the zero is not a major requirement however as there is a common direction of change a common factor could be used. The net response in combustible gas, as with all pellistors, will decrease as the ambient and gas temperature increases. Another common factor could be added to further improve the accuracy of the sensor.





In TC mode, compensation of the zero output is required as the resistance of the compensator will change with temperature unlike that of the resistor. Compensation of the response in Methane is not required as the response curve does not significantly change with temperature. Response curves are independent of temperature.



Output from the Temperature Sensor (Pin4)

The ambient temperature in Degrees Celsius is derived from the output of the temperature sensor using the following relationship-

Temp (°C) =(V_{out}-0.424)/0.00625

For example if Vout is 0.7365 the ambient temperature is 50°C.

Calibration and Sensor Linearity

Catalytic Mode

The sensor is linear to at least 4% Methane and as such calibration can be carried out at between 1 & 2.5% Methane. The sensor performance data was measured with the sensor inside a standard SGX calibration hood, JAS767906AA with the sensor at right angles to the flow which is set to 500 ±50 mls/min.

Thermal Conductivity Mode

The sensor response is measured using the same set up as above however the response is non-linear. The response follows a Quadratic response, ax^2+bx+c. As the bridge is zeroed c will be 0 ; typical values for a & b are 0.0035 & 0.701 respectively.

For optimum accuracy at least 3 point calibration using 2 known methane concentrations should be carried out. It has been shown that 3 point calibration in Air (0% Vol CH4) , 40% and 100% Volume Methane will produce a calibration curve where the results meet the requirements of EN 60079-29-1 2007 part 5.4.3.2 i.e. within ±3% Methane or ±5% of indication

Determination of Switching Points

Once calibrated the catalytic sensors should be arranged to be switched off when the displayed Methane LEL exceeds 60% LEL/ 2.64% Methane. The TC sensors are then turned on. This is to protect the sensor from exposure to excessive levels of gas.

In TC mode the process is reversed when the displayed % Methane LEL has dropped to 50% LEL / 2.2% Methane.

In real applications it may be prudent to turn on the sensor initially in TC mode in case the instrument has been turned on in high gas. If the gas concentration is <2.2% Volume the catalytic sensors will then be turned on.

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