Xensor Integration
Designing, prototyping, manufacturing

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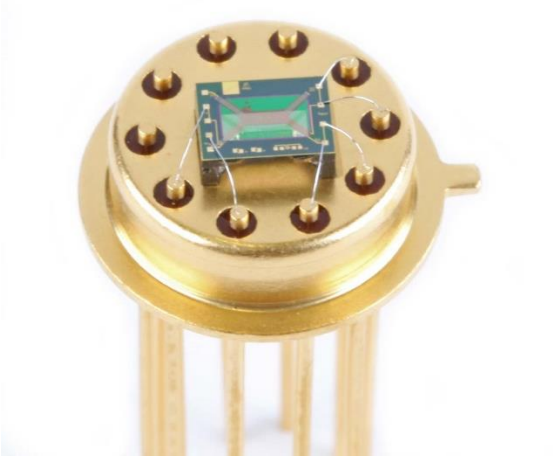
XEN-TCG3880

Thermal Conductivity Gauge

The XEN-TCG3880 thermal conductivity gauge measures thermal conductivity of the surrounding gas. Operating on the principle that gases differ in their thermal conductivity, it can be used to measure gas concentration in binary mixture or quasi-binary mixture where component gases have different thermal conductivity. It can also be used as a Pirani gauge to measure pressure in vacuum systems.

The sensor chip consists of a silicon rim with a silicon-nitride membrane. In the center is a heater, with a sensor element measuring its temperature. The chip measures the thermal conductance between the ambient and the center of the membrane.



Features

- Long-term stable analysis of gases in binary and quasi-binary mixtures
- Non-selective gas concertation measurement
- High sensitivity and resolution
- Operating temperature: -250 °C to 240 °C
- Humidity: 0 to 95% RH, non-condensing

Technical Specifications

Ambient temperature 22 °C and 1 V power supply

Dimensions	
size naked die (mm²)	2.50 x 3.33
thickness naked die (mm)	0.3
thickness membrane (µm)	1
weight on TO-5 (g)	0.72
weight on TO-5 + cap + filter (g)	1.05
Output	
in vacuum at 0 mbar (V/W)	130
in air at 100 kPa (V/W)	30
in air at 10 MPa (V/W)	26
in helium at 100 kPa (V/W)	7
in helium at 10 MPa (V/W)	6.9
Time constant	
in air (ms)	9
in vacuum (ms)	36
Stability	
short term, 1 day (ppm)	1
long term, 1 year (ppm)	300
Thermal resistance	
membrane (kK/W)	100
membrane + gas (kK/W)	23
Maximum heating voltage	
in air (V)	2.5
in vacuum (V)	1

Applications

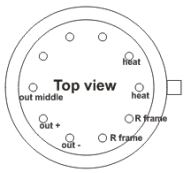
- Measurements of the thermal conductivity of gases and gas mixtures and vacuum measurement
- Monitoring and leak detection of hydrogen, helium, nitrogen and methane gas mixtures in medical, R&D and industrial environments.

Principle of operation

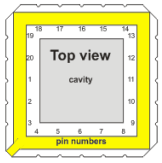
The XEN-TCG3880 thermal conductivity gauge performs a measurement of the thermal resistance between the hot junctions of its thermopile in the center of the membrane and the cold junctions on the thick rim of the chip. This is achieved by heating the center of the membrane using the heater resistor. The resulting temperature increase of the center is measured by the thermopile. The actual temperature increase depends upon the effective thermal resistance between membrane center and ambient, this is influenced by factors such as thermal resistance of the membrane, that of the ambient gas, any present gas flows, and (usually negligible) emitted radiation.

Housing

The XEN-TCG3880 is available without housing as naked die on a silicon carrier or mounted on top of TO-5 or LCC-20nn housing.



TO-5



LCC-20nn

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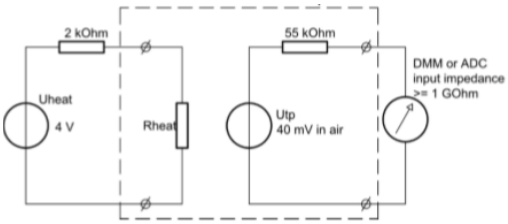
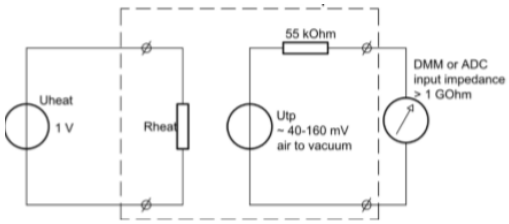
Electronics and Biasing

The operation and read-out of the XEN-TCG3880 can be done using a non-feedback type of biasing. The heater is supplied with a constant voltage, current, or power supply of mixed characteristic. The output voltage is measured using a (digital) multimeter (DMM) or using an AD-converter. If the DMM is of adequate quality and with sufficient input resistance, it can directly measure the output voltage of the XEN-TCG3880. The simplest biasing scheme for a gas-type determination is shown in the figure below, where a series resistance of 2 kOhm is inserted before the heater to minimize the overall temperature coefficient of the output voltage. In case of read out of the output voltage with an ADC with inadequate range or input resistance, the output signal needs to be amplified or buffered first. Depending upon the electronics used various op-amps can be applied.



Constant voltage biasing of the XEN-TCG3880 with 2 kOhm series resistance.



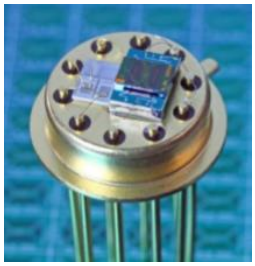
Constant voltage biasing of the XEN-TCG3880 for vacuum measurement

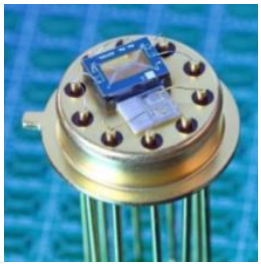
Options

Several additional options for the sensing element are available.

- For naked die: silicon carrier or silicon beams to ventilate the etched cavity
- For all versions: silicon roof to reduce flow sensitivity
- For all versions: gold metallization and wire bonds to reduce corrosion sensitivity
- For TO-5 / LCC-20 versions: temperature measurement element Pt100 or Pt1000
- For TO-5 versions: welded cap with a 5 mm Ø filter to mechanically protect and reduce flow sensitivity
- For TO-5 versions: calibration adapter to conduct flow over the sensing element
- For TO-5 versions: ultra-fast sensing construction, time constant typically < 0.05 s
- For TO-5 versions: a TO-5 10-pins socket is available and a PCB-mounted version


Welded cap with filter


Roof Si cover


Pt100 / Pt1000