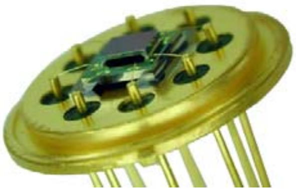
# TCS208F Thermal Conductivity Sensor



- **Thermal conductivity sensor for gases**
- **Silicon micromechanics**
- **Very small dimensions**
- **Short time constants**
- **Measurement of very small gas volumes**
- **Gas exchange by diffusion**

## DESCRIPTION

The sensor element consists of a silicon chip with a thin membrane approximately 1mm² in size of a material with extremely good electrical and thermal insulating properties. On the membrane are two thin film resistors ($R_{m1}$, $R_{m2}$) which are both used for heating the membrane and for measurement of membrane temperature Tm. The resistors are passivated to protect them from the effects of the gas. The membrane is completely covered by a second small silicon chip with a rectangular cavity etched in. The hollow space thus formed above the membrane is the thermal conductivity section. The gas comes to the measuring section through a small lateral opening in the membrane cover by diffusion only, and not by flow.

The sensor chip and its cover are attached to a silicon support which also permits gas exchange to the lower side of the membrane. The sensor is electrically connected to an eight pin base by gold wire bonding.

Due to the thermal conductivity l of the gas surrounding the membrane, thermal energy is dissipated from the membrane held at higher temperature Tm. Measured is the signal needed in a temperature stabilization circuit to keep the excess temperature of the membrane DT constant.

On the solid part of the chip are two more resistors ($R_{t1}$, $R_{t2}$) to measure and compensate for the effect of the ambient temperature $\vartheta$.

## FEATURES

- Measuring hydrogen content thermal conductivity
- Analyzing binary gas by evaluating
- Determination of CO2 vs. Methane
- Discrimination of natural gas
- Measurement of Helium or Xenon contents

## APPLICATIONS

- Industrial application
- Monitoring of gas characteristic
- Determining gas concentration
- Landfill or digestor gas
- Different origin gas or compositions gas

# TCS208F Thermal Conductivity Sensor

## ABSOLUTE MAXIMUM RATINGS

| Description | min. | typ. | max. | Unit |
|---|---|---|---|---|
| Heating power P ($R_{m1}$ + $R_{m2}$) | | | 30 | mW |
| Membrane temperature $T_m$ | | | 180 | °C |
| Ambient temperature $\vartheta$ | -20 | | +85 | °C |
| Gas pressure on base[1] | | | | |

## SPECIFICATION

| Description | min. | typ. | max. | Unit |
|---|---|---|---|---|
| Resistances $R_{m1}$, $R_{m2}$ ($T_{amb}$ @ 25°C) | 92 | 100 | 115 | Ω |
| Resistances $R_{t1}$, $R_{t2}$ ($T_{amb}$ @ 25°C) | 220 | 240 | 275 | Ω |
| Quotient $R_{tx}$ / ($R_{m1}$ + $R_{m2}$) \| x ε {1,2} | 1.13 | 1.2 | 1.27 | |
| Resistance difference $R_{m1}$ - $R_{m2}$ | -2.00 | | +2.00 | Ω |
| Temperature coefficient ($R_m$, $R_t$) \| 20°C – 100°C ($\alpha$)[2] | 4800 | 5500 | 5900 | ppm/K |
| Geometry factor (G)[3] | | 3.6 | | mm |
| Membrane thermal time constant ($\tau_m$) | | < 5 | | ms |
| Time constant for gas exchange ($\tau_{diffusion}$) | | <100 | | ms |
| Drift (Rxy) \| x ε {m,t} ; y ε {1,2} | | 0.001 | 0.01 | %/week |
| Volume of diffusion chamber structure | | 0.2 | | mm³ |
| Surrounding volume to be kept clear (see Fig.5) | | 100 | | mm³ |

Base material: Silicon, microstructured by anisotropic etching

Dimensions of sensor: (see Fig.1)
excluding base approx. 3.5mm × 3.5mm × 1.2mm
including base approx. 13mm Ø × 15.4mm

Material of parts exposed to gas: Si, SiNx, gold, epoxy

Mechanical stress tests have been performed on prototype sample devices for:

Vibration: in accordance with IEC 68-2-6 Appendix B (1982) 10 cycles; ±1.5mm; 20g; 10...2000Hz; 1octave/min

Shock: in accordance with IEC 68-2-27 Amendment #1 (Oct.82) 10 shocks each radial and axial; 100g; 7.5ms / 300g; 2.5ms / 900g; 1.2ms

## RECOMMENDED OPERATING CONDITIONS

| Description | min. | typ. | max. | Unit |
|---|---|---|---|---|
| Heating power P ($R_{m1}$ + $R_{m2}$) | | | 5 | mW |
| Membrane excess temperature $\Delta T = T_m - \vartheta$ | (30) | 50 | 70 | °C |

The minimum $\Delta$T for any application is determined by the resolution of thermal conductivity $\lambda$ required in combination with the noise of the amplifier circuit used. A very low $\Delta$T has advantages in terms of linearity, low drift and better long-term stability of the sensor.

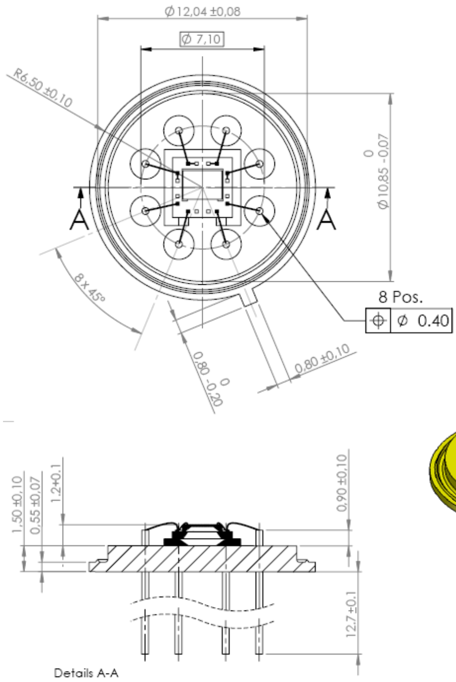
---

[1] Pressure data according to supplier specifications for properly supported device

[2] min. value of $\alpha$ quoted only for applications to be compatible with a potential second source of lower specs. Product is constantly being improved to get closer to DIN 43760 specifications.

[3] The factor G is determined by the internal sensor geometry.

## MECHANICAL DIMENSIONS



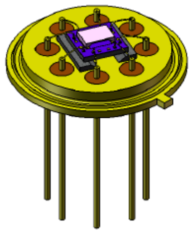



Fig. 1 Dimensions

All dimensions in mm