MTCS 2601 - Pressure

Thermal Conductivity Sensor for Leak or Pressure detection

Applications

• Primary vacuum control following Pirani principle. This sensor is easily added within a pressure valve or directly in vacuum pipes or systems, such as small mechanical pumping systems, vacuum pumping machine and analytical instruments

• Leakage miniature SMD sensor as control integrity of closed systems or instruments under dedicated pressure, able to detect defect like corrosion or simply box opening (load cells; flywheel systems, Dewar…)

Advantages

• Thermal conductivity sensor for primary vacuum measurement

• Silicon device in SMD ceramic package. Delivery in Tape & Reel

• Small dimension compatible with measurement in very small volume

• Low power consumption and short time constants

• Optimal sensitivity in the range 10^{-2} to 10^{+2} mbar. Possible extension in the range 10^{-4} to P_{atm}

• Low cost for volume application

General description

The **MTCS2601** sensors consist of a micro-machined thermal conductivity sensor using four Ni-Pt resistors realized using MEMS technologies. The sensor is mounted in a miniature SMD package, available on tape and real. This MEMS TC sensor, combined with simple low power CMOS standard integrated circuits, is an excellent choice for size-critical leakage OEM detector or miniature vacuum gauge based on Pirani principle requiring ultra-low power consumption, long lifetime and no maintenance. Applications are primary pressure control in rough environment with power and size constraints, or detection in closed volume of gas leakage or moisture, or intrusion.

Features

• Robust MEMS sensor following physical Pirani principle (hot wire) with no chemical reaction, based on gas thermal conductivity variation versus pressure

• Measuring range from 10^{-4} to 1000 mbar with excellent reproducibility

• Temperature compensated with excellent matching of compensation and heating resistors on the same silicon die

• Ultra small sensor gas volume such as < 0.1 cm^3

• Robust and long MTBF (> 30’000 hs) due to physical resistive sensing principles

• Ultra-low power sensor consumption in operation (< 6 mW) due to the use of MEMS based micromachined silicon sensor with small heated mass

• Ultra-fast response time < 50 ms

• Insensitive to mounting position

• Gold contact version upon request for corrosive gas environment

• Compatible with a simple constant excess temperature operation circuit

Electrical specification

Description	Symbol	Min	Typical	Max	Units
Measuring resistance at 23°C ± 2°C	Rm_1 and Rm_2	110	120	135	Ω
Reference resistance at 23°C ± 2°C	Rt_1 and Rt_2	240	265	300	Ω
Ratio	$(Rt_1+Rt_2)/(Rm_1+Rm_2)$	2.00	2.20	2.35	-
Resistance difference	Rm_1-Rm_2	-1.5		+1.5	Ω
Resistance difference	Rt_1-Rt_2	-3.5		+3.5	Ω
Temperature coefficient (Rm, Rt) 20°C - 100°C	α	0.0045	0.0050	0.0055	/°C
Geometry factor	G		3.9		mm
Thermal loss coefficient			0.101		µm

Absolute maximum ratings

Description	Symbol	Min	Typical	Max	Units
Heating current in (Rm_1+Rm_2) – Air; Ta=23°C	Ih			6.2	mA
Heating Power (Rm_1+Rm_2) – Air; Ta=23°C	P			15.8	mW
Membrane temperature	Tm			180	°C
Ambient temperature	Ta	-20		100	°C
Humidity – No condensing	RH	0		100	%

Recommended operating condition

MTCS2601 has four resistors connected separately:

• Rm_1 and Rm_2 are located on the membrane and are used for heating/measurement.

• Rt_1 and Rt_2 are located on the “cold part” of the device and are used for temperature measurement and compensation.

• For pressure measurement in primary vacuum, a constant excess temperature operating mode is recommended. Such circuits are presented below.

• As the conductivity change is important in this range of pressure and can be rapid depending on the application, this is the best way to avoid any damage on the sensor.

Storage condition

• Temperature: -40 to +100°C

• Humidity: 0 – 100% RH , non condensing

Mechanical stress tests

• Chocks: 1000 g, 0.2 ms, half-sine (one meter onto concrete drop)

• Vibrations: 10 g RMS, sine wave sweep 20 – 2000 Hz

Base material

• Silicon, micro-structured by anisotropic etching

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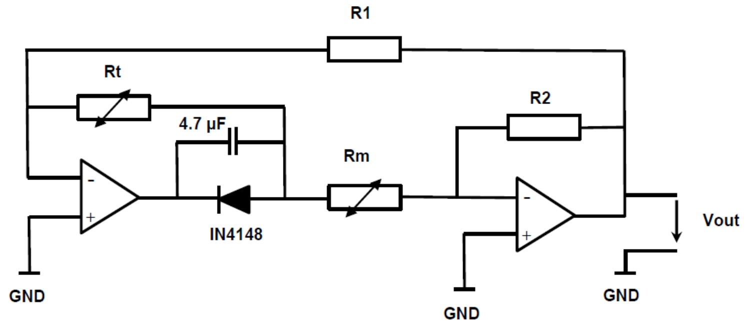
Recommended application circuit: constant excess temperature operation

The **recommended constant excess temperature application circuit** is presented below. The diode determines the polarity of the loop output voltage Vout, positive values in the circuit below. Such circuit is fully compatible with rapid change in thermal conductivity over a wide range of pressure $[10^{-5};10^{+3}]$ mbar.



Recommended Op-Amps: TSG922 for example

There are two possible circuits. In both cases, the two membrane heating/measuring resistors Rm1 and Rm2 are connected in series: $Rm=Rm_1+Rm_2$

(1) $$\frac{R1}{R2}=\frac{Rt(Ta)}{Rm(T)} \qquad \frac{R1}{R2}=\frac{Rt(Ta)}{Rm(Ta)*\left(1+\frac{\alpha\Delta T}{1+\alpha Ta}\right)}$$

α= temperature coefficient at =0°C; ΔT=(T-Ta) with Ta=ambient temperature and T is the heating temperature

Using such quotient in the loop, this signal is first order temperature compensated.

(2) $$\Delta T=\frac{(1+\alpha Ta)}{\alpha}*\left[\frac{R2Rto}{R1Rmo}-1\right]$$

(3) $$Vout^2=\frac{R2*G*\lambda}{\alpha}*\left(\frac{Rt0*R2-Rm0*R1}{Rm0*Rt0}\right)$$

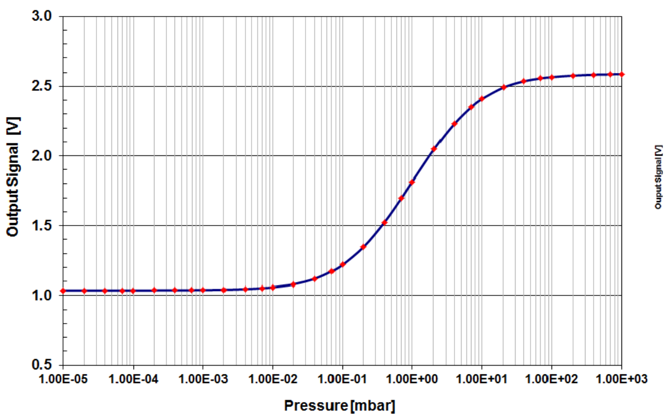
λ = thermal conductivity of the gas; G=geometry factor
Rm(T)=Rmo*(1+α*T); Rt(T)=Rto*(1+α*T)

Circuit a) In this case, the two resistors Rt_1 and Rt_2 are connected in series
Recommended resistors values: R_1=1000 Ω; R_2=560 Ω.

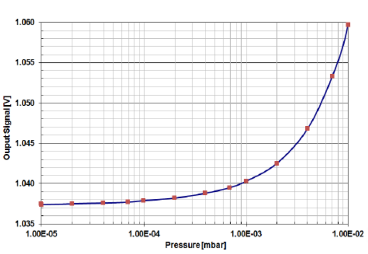
Circuit b) In this case, only one of the two resistors Rt_1 or Rt_2 is used in the loop, i.e. Rt_1. This allows the other resistor Rt_2 to be used as an additional second order temperature compensation
Recommended resistors values: R1=500 Ω; R2=560 Ω.

Using these values, a typical excess temperature ΔT=50°C is obtained. The output signal is typically 2.5 volt, with a sensitivity of 0.5 volt/decade in the range 0.1 to 10 mbar

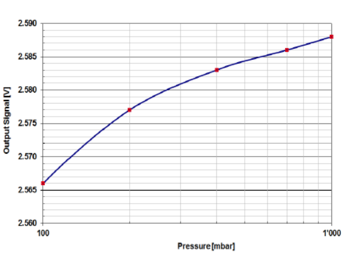
MTCS2601 response versus pressure in the range $[10^{-5};10^{+3}]$ mbar



Output Signal versus Pressure in the range $[10^{-5};10^{+3}]$ mbar - Typical curve –



Response detail in the range $[10^{-5};10^{-2}]$ mbar



Response detail in the range [100 ;1'000] mbar

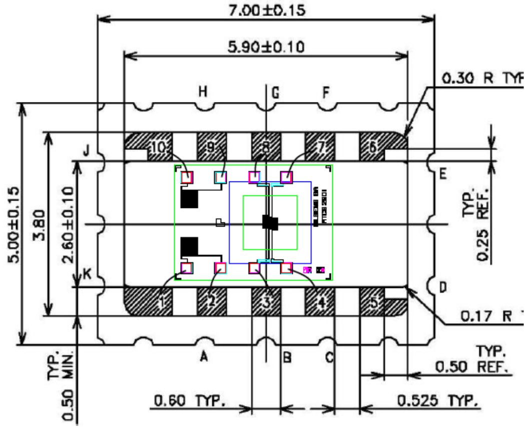
Sensor package information

All resistances are individually bonded

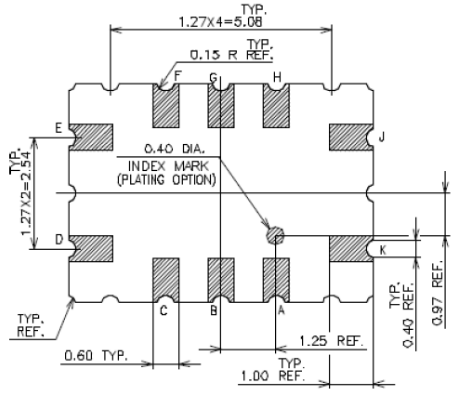
Pin-out & package general information	
Overall size of the SMD package with protective grid	7.00 x 5.00 x 1.50 mm
Pin-out - Rm1	Top side view (4–7); Back side view (C-F)
Pin-out - Rm2	Top side view (3–8); Back side view (B-G)
Pin-out - Rt1	Top side view (1–2); Back side view (K-A)
Pin-out - Rt2	Top side view (9–10); Back side view (H-J)
	(5,6) ; (E,D) : not connected
Gold wire	
Metal pads	Standard Al; Au on request
Protective grid	Anodized aluminum
Soldering information	Max: 250°C; 90 seconds
Delivery condition	Tape & Reel 16 mm

<u>Connection</u>:

(1-K) ; (2-A) ; (3-B), (4-C)
(7-F) ; (8-G) ; (9-H) ; (10-J)



Top View



Back side View

A specific PTFE filter can be added on the grid to avoid risk of water drops or oil drops onto the sensor for dirty environment conditions

<u>Parts exposed to vacuum</u>: aluminum, bulk silicon, silicon dioxide, silicon nitride, fused quartz, metallic grid

Ordering information

Part number	**Description**
MTCS2601	Sensor in LCC package with a metallic grid

Tape & Reel delivery: typically 740 sensors/reel

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