Microsens Semiconductor Gas Sensor

MSGS-3002 Methane Gas Sensor

General description

Operating principle

The measurement of specific oxidizing or reducing gases is based on reversible conductivity change of the sensing element.

Sensor description

■ MSGS-3002 Integrated semiconductor methane (CH_4) gas sensors are manufactured using standard microelectronic technology and silicon micromachining techniques.

■ The batch fabrication process of MSGS-3002 miniaturized gas sensors presents the advantages of low cost, reproducibility, small size and low power consumption.

■ The MSGS-3002 structure consists of a doped tin-oxide (SnO_2) thin-film layer over an embedded thin film heater (figure 1). This integrated heater resistance (R_H) is used to control the sensitive layer temperature which is necessary for Chemisorption Reaction mechanisms to properly occur. These mechanisms modifies the sensitive layer resistance (R_S) by reversible electron charge transfer from surface states to the conduction band.

■ The operating temperature is controlled by V_H applied on the heater resistor (R_H). A polarization voltage (V_S) is applied to the sensitive layer which resistance can be mesured using an electric circuit shown in figure 4. The 4-pins package is indicated on figure 2.

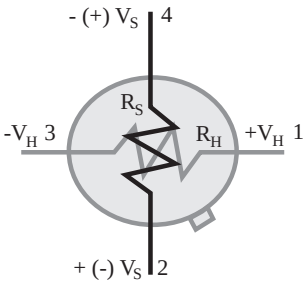


Figure 2: Sensor equivalent circuit (Top View)

PIN NUMBER	
1	Heater Power
2	Sensor Pin
3	Heater Ground
4	Sensor Pin

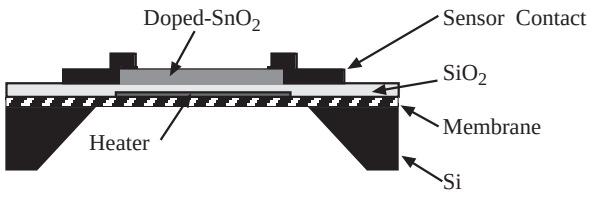


Figure 1: Schematic drawing

Features

- Sensitivity range: 100 to over 10000 ppm CH_4
- Low humidity dependence in recommended operation mode
- Stable long-term operation
- Active charcoal filter for enhanced selectivity
- Small size
- Low power consumption
- Durable nylon exterior shell with steel mesh

Application examples

- Security
  - Residential CH_4 Detectors
  - Industrial Stationary and Portable CH_4 Detectors and measurement systems
- Industrial process control

MSGS-3002 CH_4 Sensor specification [1-2]

Device specifications[1]

- Chip Dimensions:
  1.4mm x 1.4mm x 0.38 mm
- Sensor Dimensions mounted on a TO-39 package with a filter:
  Ø = 10.3 mm; h = 24.0 mm
- Typical thermal loss coefficient:
  ß = 0.12 mW/°C
  ß = ØP/ØT; ß = P/(T-Ta)

- P = heating power (mW)
- Ta = ambient temperature (°C)
- T = gas sensor temperature (°C)

Table 1: Absolute Maximum Ratings

Rating	Symbol	Value	Unit
Maximum Heater Supply Voltage (pins 1 & 3)	V_H	2	V
Maximum Heater Supply Current (pins 1 & 3)	I_H	32	mA
Maximum Sensor Circuit Voltage (pins 2 & 4)	Vs	5	V
Maximum Heater Power Dissipation	P_H	65	mW
Maximum Sensor Power Dissipation	Ps	1	mW
Maximum Heating Voltage Ramp	t_{HR}	0.2	V/ms
Operating Ambient Temperature	Tao	0 to +50	°C
Storage Temperature Range	Tsto	-40 to +70	°C

Table 2. Recommended Electrical Operating Conditions

Characteristics	Symbol	Typical value	Unit
Heating Voltage - Low - 10 seconds (pins 1 & 3)	V_H	1.2	V
Heating Voltage - High - 5 seconds (pins 1 & 3)	V_H	1.8	V
Heater current - Low - 10 seconds (pins 1 & 3)	I_H	27	mA
Heater current - High - 5 seconds (pins 1 & 3)	I_H	31	mA
Heater Power Dissipation - Low - 10 seconds	P_H	32	mW
Heater Power Dissipation - High - 5 seconds	P_H	56	mW
Average Power Consumption	P_H	40	mW
Heater Resistance (V_H = 0 volt)	R_H(Ta)	23	Ω
Heater Resistance (V_H = 1.8 volt)	$R_H(T_{High})$	57	Ω
Load Resistance	R_L	Variable (PS<1mW)	Ω

Table 3. Sensitivity Characteristics[3]

Characteristics	Symbol	Typical value	Unit
Sensor Resistance (in Synthetic air)	R_S(air)	1000	KΩ
Sensor Resistance (in 5000 ppm CH_4)	R_S(5000)	330	KΩ
Sensor Ratio R(air)/R_S(10000)	S(air/10000)	4	---
Sensor Ratio R(air)/R_S(5000)	S(air/5000)	3	---
Sensor Ratio R(air)/R_S(2000)	S(air/2000)	2	---
Sensor Ratio R(2000)/R_S(10000)	S(2000/10000)	2	---

Standard test conditions: R_H = 50 ± 2%; Ta = 23 ± 1°C. The measurement is performed at the end of the **"High"** temperature phase.

Notes:

1. The following specifications apply to the MSGS-3002 CH_4 sensor are subject to change to accommodate continuous improvement.
2. The heating conditions limits must be observed and limited as described in Table 1. Permanent damage may occur if the maximum power is exceeded.
3. Based on recommended operation:
   V_H(High temperature) = 1.8 volt (5 sec.);
   V_H(Low temperature) = 1.2 volt (10 sec.)

Measurement test circuits

■ Two different basic electric circuits which can be used with the gas sensors are presented on the figure 4. The amplifier system (2) presents however the advantage of maintaining a constant voltage V_C on the sensitive layer. A constant-current test circuit can also be used for the gas sensors, considering the recommendation of Table 1 (maximum power sensor dissipation of 1 mW).

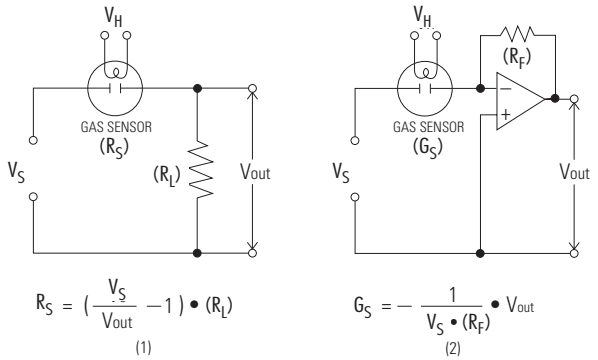


Figure 4: Basic electric circuit for gas sensor

Mode of operation

Principle

■ An operating mode based on a sequence of two heater temperatures is used for the CH_4 detection. This operating mode minimizes the influence of humidity. During the "High" temperature period (5 seconds), water and contaminants are removed from the surface of the sensitive layer, while the high temperature allows the CH_4 dissociation/reaction with the adsorbed oxygen species. The CH_4 measurement is carried out at the end of the "High" temperature phase (5 seconds).

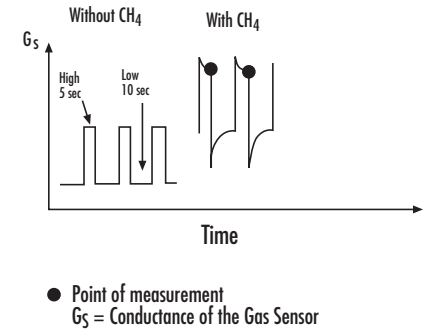


Figure 5: Principle of the operating mode

Humidity Influence

■ Figure 7 presents results obtained in different relative humidity. These results confirm the efficiency of the operating mode proposed to decrease the moisture influence.

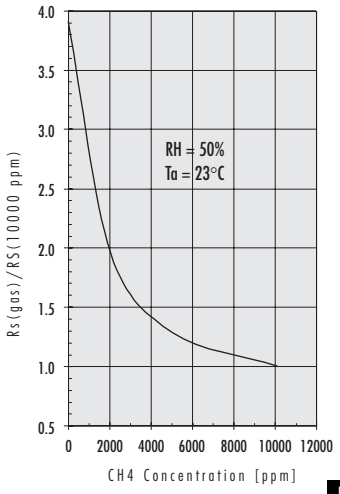


Figure 6: CO Sensitivity

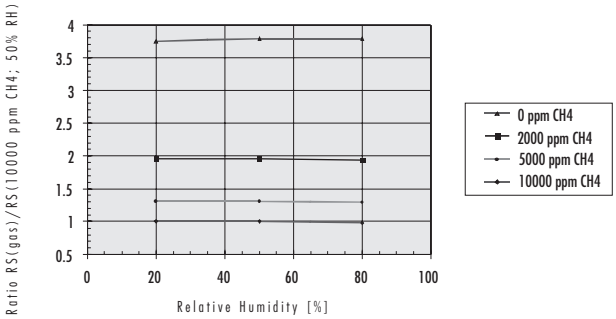


Figure 7: Humidity Influence (Ta=23°C)

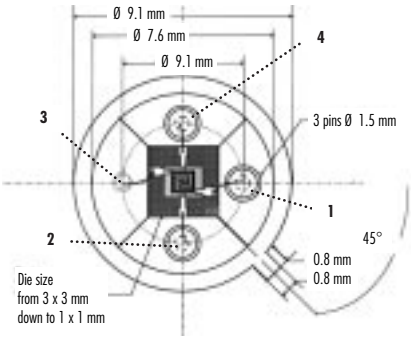
Sensors precautions

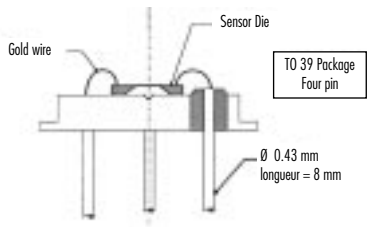
- Avoid to overheat the sensor (see Table 1)
- ESD protection is required when handling these devices

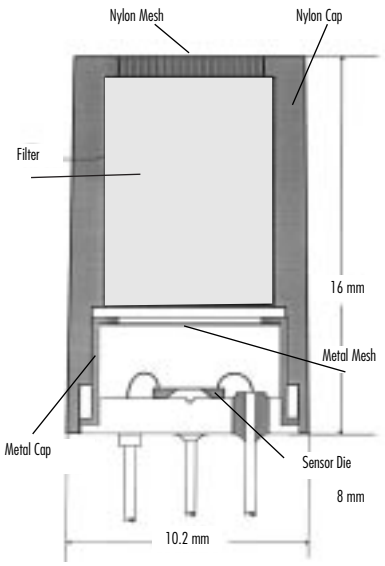
Packaging characteristics

■ The standard packaging used a TO-39 support (cf. description in the previous Data Sheet). A charcoal filter placed in a nylon casing reduces the effects of interfering gases.

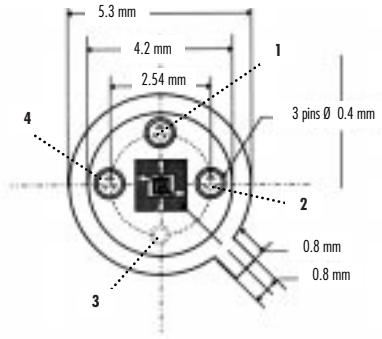
MSGS-3002-B
TO-39 PACKAGE

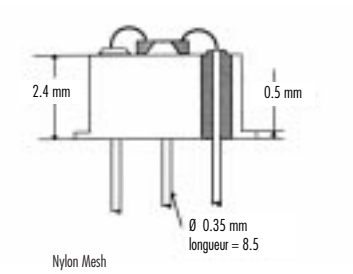


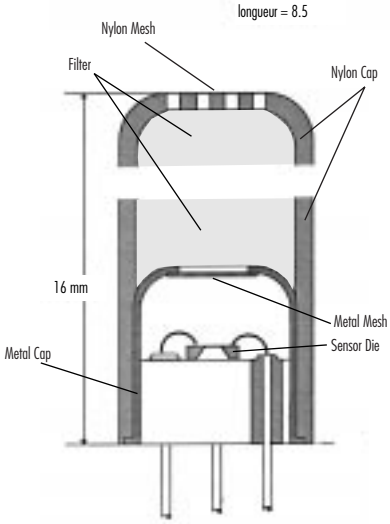




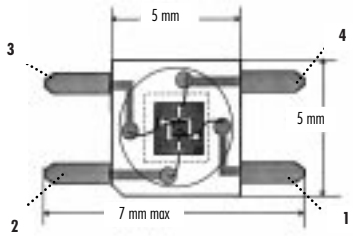
MSGS-3002-D
TO-18 PACKAGE

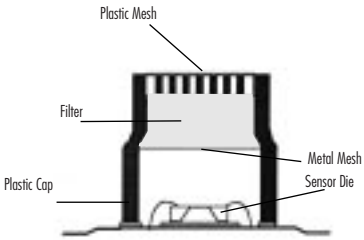






MSGS-3002-E
PLASTIC PACKAGE





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