Microsens Semiconductor Gas Sensor

MSGS-3001 Carbon Monoxide 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-3001 Integrated semiconductor carbon monoxide (CO) gas sensors are manufactured using standard microelectronic technology and silicon micromachining techniques.

■ The batch fabrication process of MSGS-3001 miniaturized gas sensors presents the advantages of low cost, reproducibility, small size and low power consumption.

■ The MSGS-3001 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.
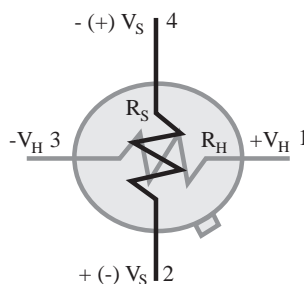

Figure 2: Sensor equivalent circuit (Top View)

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

Features

- Sensitivity range: 5 to over 1000 ppm CO
- Low humidity dependence in recommended operation mode
- Stable long-term operation
- Active charcoal filter for enhanced selectivity
- Low power consumption
- Small size
- Durable nylon exterior shell with steel mesh Sensor Pin

Application examples

- Security
- Residential CO Detectors
- Industrial Stationary and Portable CO Detectors and Probes
- Combustion control
- Environment
- Indoor air quality
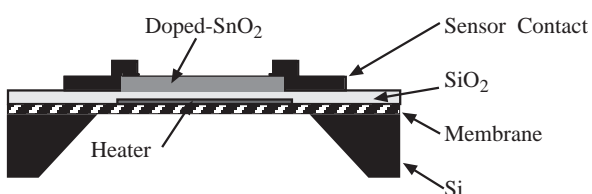- Industrial process control

Figure 1: Schematic drawing

MSGS-3001 CO Sensor specifications [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:
  $\emptyset$ = 10.3 mm; h = 24.0 mm
- Typical thermal loss coefficient:
  ß = 0.12 mW/°C
  ß = $\emptyset P / \emptyset T$; 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)	V_S	5	V
Maximum Heater Power Dissipation	P_H	65	mW
Maximum Sensor Power Dissipation	P_S	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	0.8	V
Heating Voltage - High - 5 seconds (pins 1 & 3)	V_H	1.8	V
Heater current - Low - 10 seconds (pins 1 & 3)	I_H	24	mA
Heater current - High - 5 seconds (pins 1 & 3)	I_H	31	mA
Heater Power Dissipation - Low - 10 seconds	P_H	20	mW
Heater Power Dissipation - High - 5 seconds	P_H	56	mW
Average Power Consumption	P_H	32	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)	$R_S(air)$	36	$M\Omega$
Sensor Resistance (in 100 ppm CO)	$R_S(100)$	4	$M\Omega$
Sensor Ratio R(air)/$R_S(100)$	S(air/100)	9	---
Sensor Ratio R(air)/$R_S(60)$	S(air/60)	6	---
Sensor Ratio R(air)/$R_S(15)$	S(air/15)	2	---
Sensor Ratio R(15)/$R_S(100)$	S(15/100)	4	---

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

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).
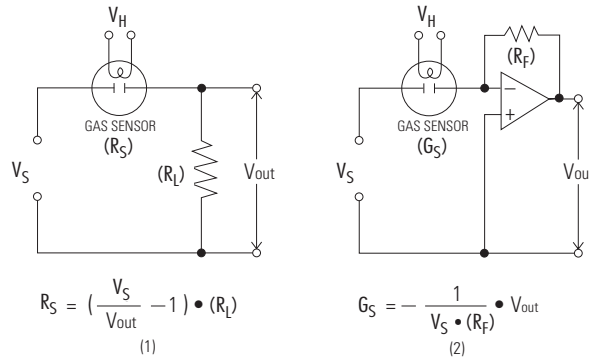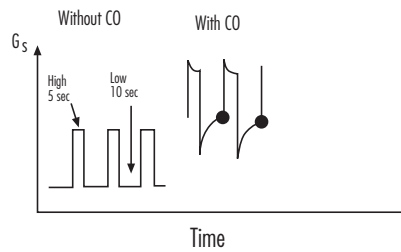

$$R_S = \left(\frac{V_S}{V_{out}} - 1 \right) \bullet (R_L)$$
(1)

$$G_S = - \frac{1}{V_S \bullet (R_F)} \bullet V_{out}$$
(2)

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 CO detection. This operating mode increases the CO sensitivity while the influence of humidity is minimized. During the "High" temperature period (5 seconds), water and contaminants are removed from the surface of the sensitive layer, while the thermal energy of the adsorbed oxygen species is increased which causes a drastically higher catalytic conversion from CO to CO_2. The CO measurement is carried out at the end of the "Low" temperature phase (10 seconds).

● Point of measurement
G_S = Conductance of the Gas Sensor

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.
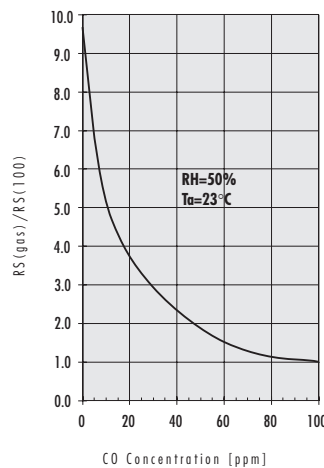

Figure 6: CO Sensitivity

Sensors precautions

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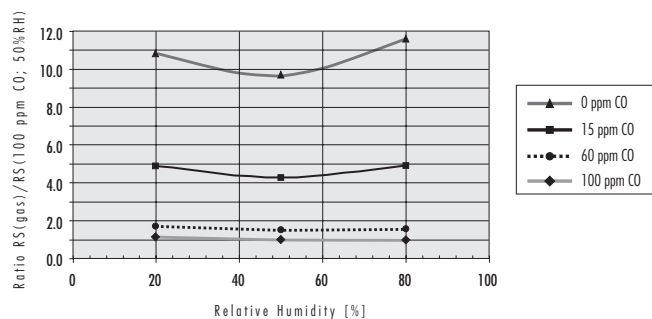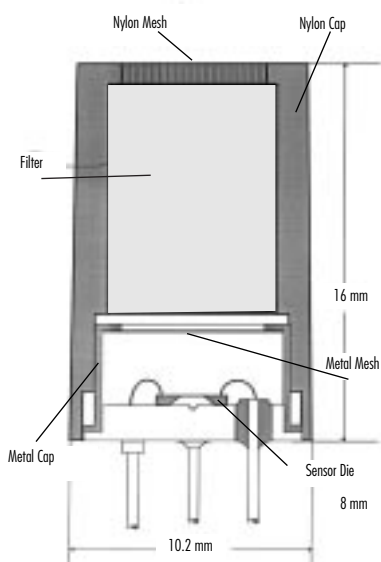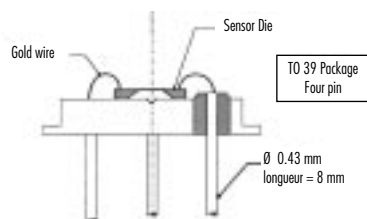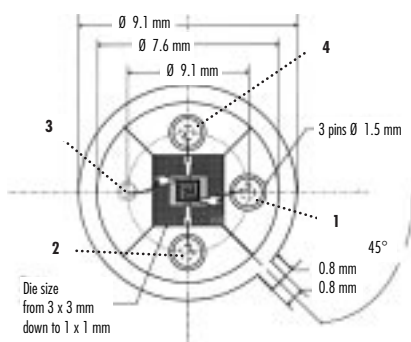- ESD protection is required when handling these devices
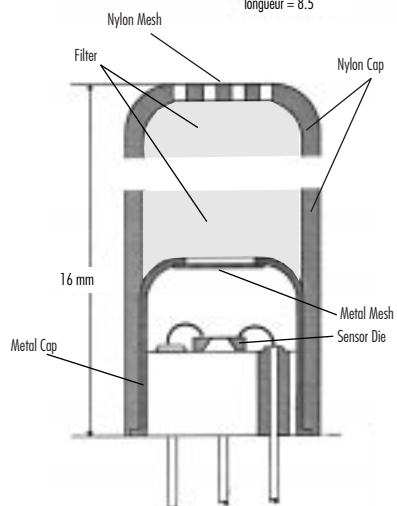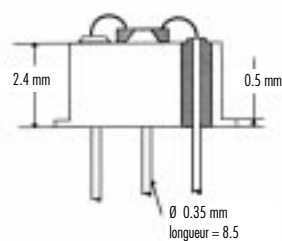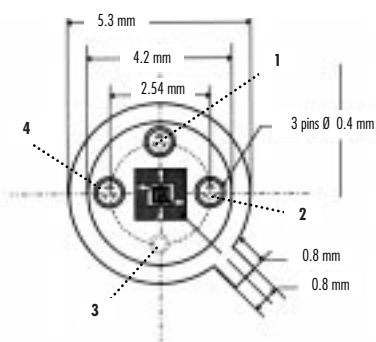

Figure 7: Humidity Influence (Ta=23°C)

Packaging characteristics

■ The standard packaging used a TO-39 support. A charcoal filter placed in a nylon casing reduces the effects of interfering gases.
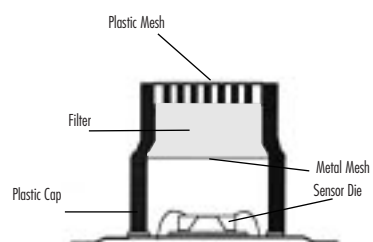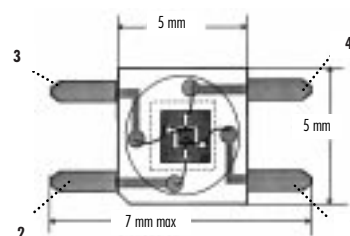
MSGS-3001-B
TO-39 PACKAGE

Ø 9.1 mm
Ø 7.6 mm
Ø 9.1 mm

4

3

3 pins Ø 1.5 mm

1

2

45°

0.8 mm
0.8 mm

Die size
from 3 x 3 mm
down to 1 x 1 mm

Gold wire

Sensor Die

TO 39 Package
Four pin

Ø 0.43 mm
longueur = 8 mm

Nylon Mesh

Nylon Cap

Filter

16 mm

Metal Mesh

Metal Cap

Sensor Die

8 mm

10.2 mm

MSGS-3001-D
TO-18 PACKAGE

5.3 mm
4.2 mm
2.54 mm

1

4

3 pins Ø 0.4 mm

2

0.8 mm
0.8 mm

3

2.4 mm

0.5 mm

Ø 0.35 mm
longueur = 8.5

Nylon Mesh

Filter

Nylon Cap

16 mm

Metal Cap

Metal Mesh
Sensor Die

MSGS-3001-E
PLASTIC PACKAGE

5 mm

3

4

5 mm

2

1

7 mm max

Plastic Mesh

Filter

Plastic Cap

Metal Mesh
Sensor Die

97-27