



MGS1100 Carbon Monoxide Gas Sensor

The Motorola MGS1100 carbon monoxide (CO) sensor features a gas sensitive, thin film metal-oxide layer over an embedded micro-heater, see Figure 1. The heater is used to raise the temperature of the film to enhance its sensitivity to CO. This structure is supported by a micromachined silicon diaphragm for reduced power consumption. The sensor is packaged in a 4-pin SENSEPACK™ package with a nylon overcap that supports an active charcoal filter used to selectively screen unwanted gases that can react with or damage the sensitive layer. The pins include connections to the heater ($\pm V_H$) and sensing layer ($\pm V_S$).

Features

- Sensitivity Range: 15 to over 1000 ppm CO
- Low Humidity Dependence in Recommended Operation Mode
- Stable Long-Term Operation
- Thin Film Metal-Oxide on Micromachined Silicon Diaphragm
- Active Charcoal Filter for Enhanced Selectivity
- Durable Nylon Exterior Shell with Steel Mesh
- Small Size

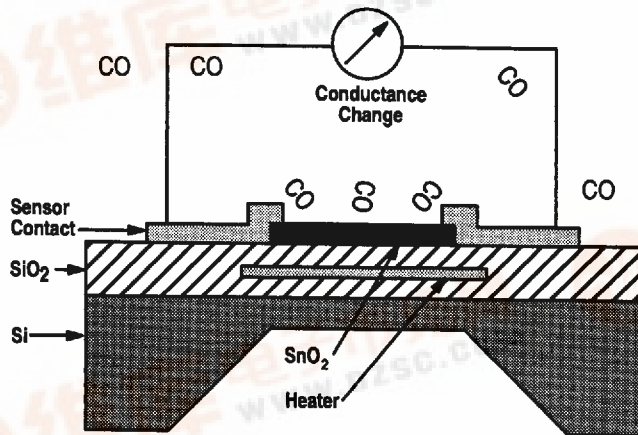


Figure 1. MGS1100 CO Sensor Cross-Sectional Schematic

Application Examples

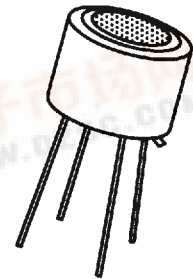
- Residential CO Detectors (UL 2034)
- Recreational Vehicle CO Detectors
- Industrial Stationary and Portable CO Detectors and Probes
- Gas/Fuel Appliance CO Monitoring

Common Sources of CO in the Home

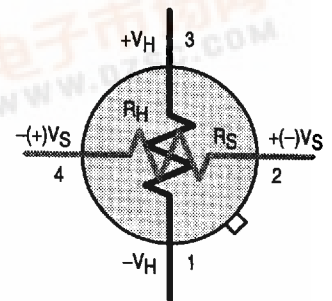
- Gas Appliances (Stoves, Dryers, Waterheaters)
- Fuel Fired Furnaces
- Fireplaces and Woodstoves
- Gas and Charcoal Grills
- Gasoline Powered Equipment and Automobiles

MGS1100

**CARBON MONOXIDE
SENSOR
(RESISTANCE CHANGE)**



4-PIN SENSEPACK™ WITH
NYLON CAP AND FILTER



SENSOR SCHEMATIC
(Top View)

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

Sensor pins (2 & 4) have opposite polarity.



MICROSENS

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Table 1. Absolute Maximum Ratings¹

Rating	Symbol	Value	Unit
Maximum Heater Supply Voltage (pins 1 & 3)	V _H	5.0	V
Maximum Sensor Circuit Voltage (pins 2 & 4)	V _S	5.0	V
Maximum Heater Power Dissipation	P _H	230	mW
Maximum Sensor Power Dissipation	P _S	1.0	mW
Maximum Heater Voltage Ramp	t _{VH}	0.5	V/ms
Operating Ambient Temperature	T _{ao}	0 to +50	°C
Storage Temperature Range	T _{sto}	-40 to +70	°C

Table 2. Recommended Electrical Operating Limits²

Characteristics (Standard Test Conditions)	Symbol	Min	Typ	Max	Unit
Heater Voltage	V _H	—	—	5.0	V
Heater Current (DC) (V _H = 4.5 V)	I _H	37	45	50	mA
Heater Power ³	P _H	—	80	—	mW
Heater Resistance (V _H = 0 V)	R _H (COLD)	72	83	94	Ω
Heater Resistance (V _H = 4.5 V) (Stabilized)	R _H (HOT)	90	105	120	Ω
Load Resistance	R _L	Variable (P _S < 1mW)			Ω

Table 3. Sensitivity Characteristics³

Characteristics	Symbol	Min	Typ	Max	Unit
Sensor Resistance (in clean air)	R _S (air)	—	1000	—	KΩ
Sensor Resistance (in 60 ppm CO)	R _S (60)	30	150	300	KΩ
Sensitivity Ratio, R _S (air)/R _S (60)	S _(air/60)	—	6.0	—	—
Sensitivity Ratio, R _S (15)/R _S (60)	S _(15/60)	2.0	3.5	5.0	—
Sensitivity Ratio, R _S (60)/R _S (400)	S _(60/400)	—	2.5	—	—
Response Time (10% to 90%) ⁴	t _R	—	—	2.0	min

Standard Test Conditions:

Caution: Heater voltage ramp not to exceed 0.5 V/msec.

Pre-Condition: 48 hours (min) in clean air with Recommended Operation.

Recommended Operation: V_H(HOT) = 5.0 V (5 sec.), V_H(COLD) = 1.0 V (10 sec.), V_S = 5.0 V, R_L = variable (P_S < 1mW).

Environment: Synthetic air, 50 ±5% RH, 22 ±3°C.

NOTES:

- The following specifications apply to the MGS1100 CO sensor and are subject to change to accommodate continuous improvement.
- The heater voltage and power must be observed and limited as described in Table 1. Permanent damage may occur if the maximum power is exceeded.
- Based on recommended operation: V_H(HOT) = 5.0 V (5 sec.), V_H(COLD) = 1.0 V (10 sec.), V_S = 5.0 V, R_L = variable (P_S < 1mW).
- Response time is defined as the time for the incremental change in the output when subjected to a 100 ppm CO step change.

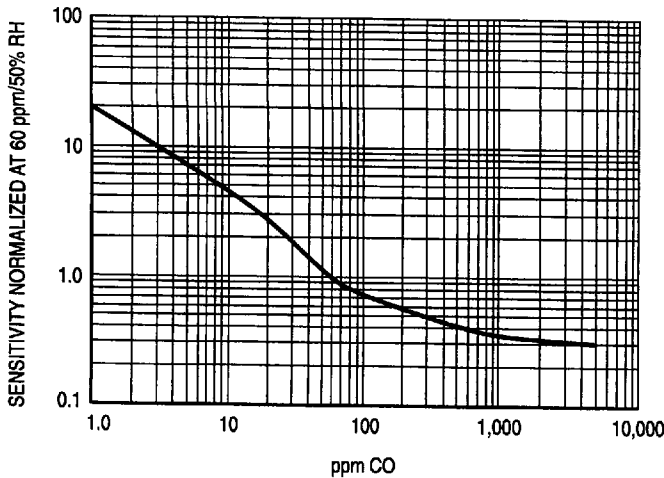


Figure 2. Typical Sensitivity Response of MGS1100 to CO at 50% RH

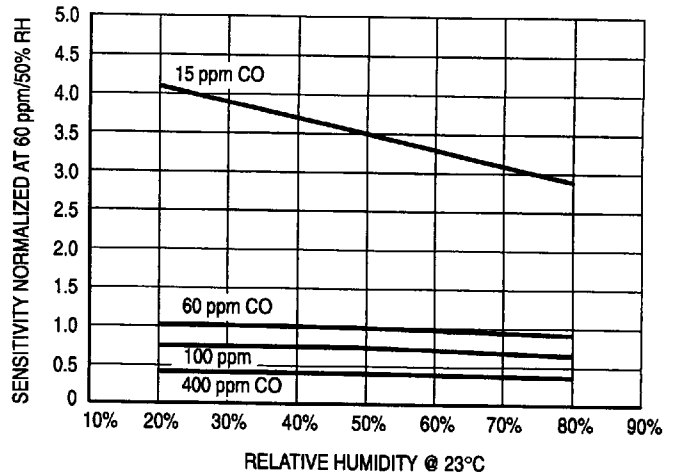


Figure 3. Typical Humidity Influence on MGS1100

TEST SETUP AND PROCEDURE

The following test procedures are recommended and used by Motorola. Deviating from these procedures may produce varying results or cause damage to the sensors.

1. Important Sensor Precautions

- The MGS1100 is a class 1 sensitive device.
- **ESD protection is required when handling these devices.**
- To avoid damaging the sensors, it is important to follow the limits in the specifications (Table 1). The heater voltage V_H must be adjusted so that the heater power is less than the 230 mW. The maximum voltage for the sensor V_S (pins 2 and 4) is 5.0 V, beyond which permanent damage may occur.
- The sensors must not be wave soldered in order to avoid poisoning the sensitive layer.
- This sensor must not be exposed to high concentrations of aggressive gases, such as organic solvents, cigarette smoke or ammonia.

2. Test Preconditioning

Before testing, the sensors must be preconditioned in flowing synthetic air for a minimum of 48 hours with recommended operation. Preconditioning in clean ambient air may require more time to stabilize the sensors and may produce different baseline resistance for R_S .

3. Testing Recommendations

For repeatable results, use synthetic air (79% N_2 , 21% O_2) as the reference air in all procedures and measurements.

4. Test Methodology

The following describes the test methodology used for several basic tests. The standard test conditions are defined in the Specification in Appendix B.

a) Sensitivity Test

Motorola defines sensitivity (S) as the ratio of the sensor resistance in synthetic or clean air to the sensor resistance in the presence of gas

$$S = R_S(\text{air})/R_S(\text{gas}) \quad (4)$$

Sensitivity measurements are taken at CO concentrations of 0, 15, 30, 60, 100, 200, and 400 ppm. Each measurement is in increasing order of concentration.

b) Humidity Influence Test

Humidity tests measure the influence of humidity on CO sensitivity. Over a range of humidity, repeat the sensitivity test at various CO concentrations. Monitor and record the temperature and humidity of the test environment.

c) Stability Test

This test is designed to measure any change of the sensor baseline resistance over time. The sensor is placed in a test chamber with a constant level of humidity and a constant temperature. After completion of 48 hours of pre-conditioning the sensor response is measured for an extended period, ranging from days to weeks. Any drift in the baseline response of the sensor can then be measured and reported as a percent drift per time.

MEASUREMENT TEST CIRCUITS

Two test measurement circuits are recommended.

1. Serial Resistor Test Circuit

A circuit voltage V_C is applied to the series network of the sensing film (R_S) and a load resistor (R_L), see Figure 4. The voltage across R_L is measured as V_{OUT} and the resistance of the sensing film may be calculated as:

$$R_S = ((V_C - V_{OUT})/V_{OUT}) \times R_L \quad (1)$$

In the presence of CO, the resistance of the SnO_2 film decreases, thus increasing the sensor current across the load resistor R_L and increasing V_{OUT} .

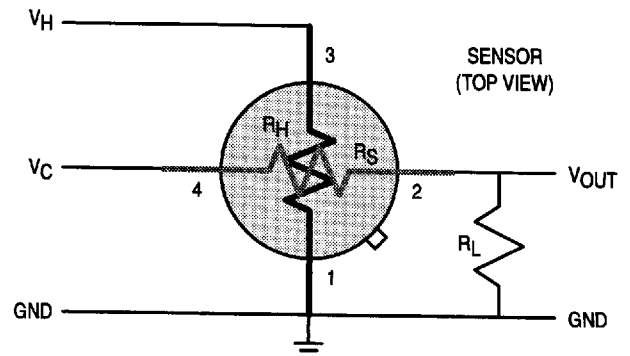


Figure 4. Test Circuit with Serial Resistor

Be sure that the voltage (V_S) across sensor pins 2 and 4 does not exceed 5.0 V.

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2. Constant-Current Test Circuit

A second measurement technique uses a constant current source across the SnO₂ (pins 2 and 4). Pins 1 and 4 are tied to a common ground and the heater circuit is identical as in the serial resistor test circuit.

The sensor resistance (R_S) can be calculated by

$$R_S = V_{OUT}/I_S \quad (3)$$

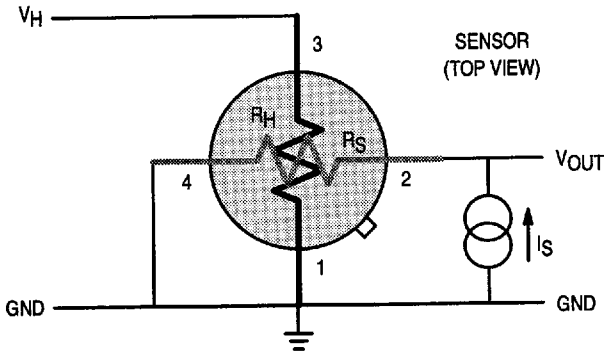


Figure 5. Test Circuit with Constant Current Source

MODE OF OPERATION

An effective method for the detection of CO gas while minimizing the influence of humidity uses a sequence of two heater temperatures. First, a hot temperature is used to remove water and contaminants from the surface of the sensing layer, then a cold temperature is used to detect the CO concentration in the air, see Table 2.

A recommended mode of operation is a hot temperature phase at $V_H = 5.0$ V for 5 seconds, then a cold temperature phase at $V_H = 1.0$ V for 10 seconds, (Figure 6). The resultant sensor temperatures are approximately 400°C and 100°C, respectively (Figure 7).

Table 4. Sensor Operation Phases

Phase	V_H (V)	t (s)	T (°C) ¹	R_S (K Ω) ²
Hot	5.0	5	400	50
Cold	1.0	10	100	1000

¹ Approximate sensor temperature.

² Typical R_S in synthetic air.

For repeatable CO measurements it is important to measure R_S at a consistent time into the cold phase (Figure 8). For example, if the cold phase is 10 seconds, measure R_S at 9.5 seconds, consistently.

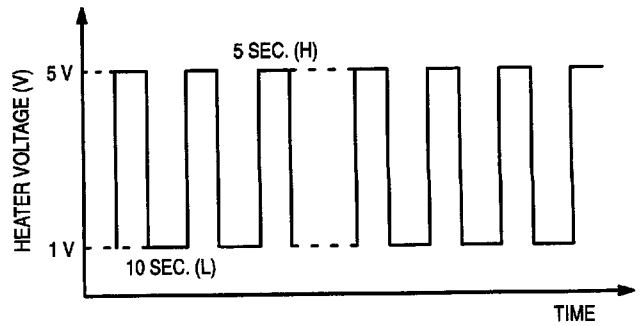


Figure 6. Heater Operation

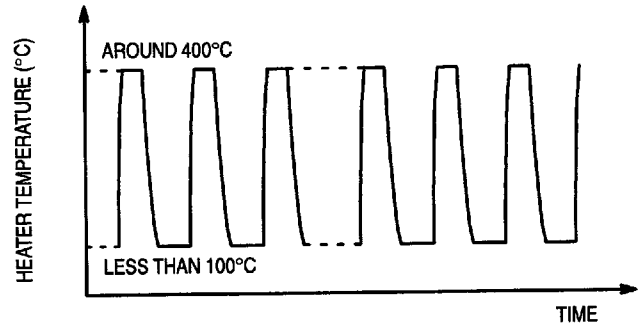


Figure 7. Heater Temperature

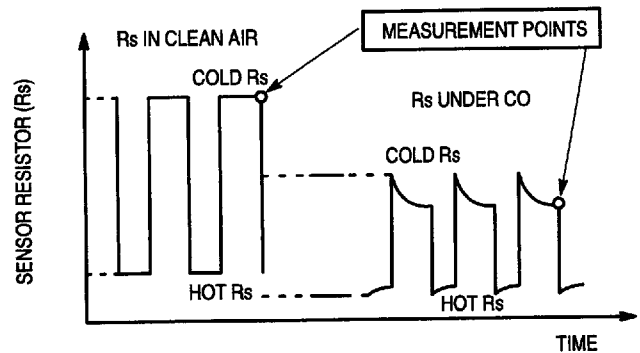


Figure 8. Sensing Element Response

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The sensor die is bonded to the header of a SENSEPACK type metal can package. An impregnated charcoal filter layer above the metal can package is then secured by a nylon casing. (The filter layer reduces the effects of interfering gases.) A wire mesh is held in place in the top opening of the nylon casing.

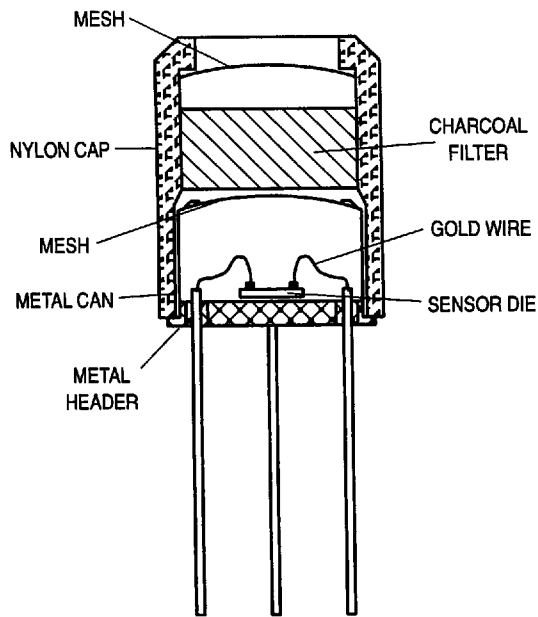


Figure 9. MGS1100 SENSEPACK™ Package Drawing

Table 5. Material List

No.	Parts	Materials
1	Gas sensitive micromachined silicon chip	Silicon with metal oxide
2	Header	Steel 1010
3	Stainless steel mesh	SUS 316 (100 mesh single)
4	Package leads	Kovar
5	Carbon filter	Impregnated cloth
6	Housing	Nylon 66
7	Metal Can	Nickel alloy

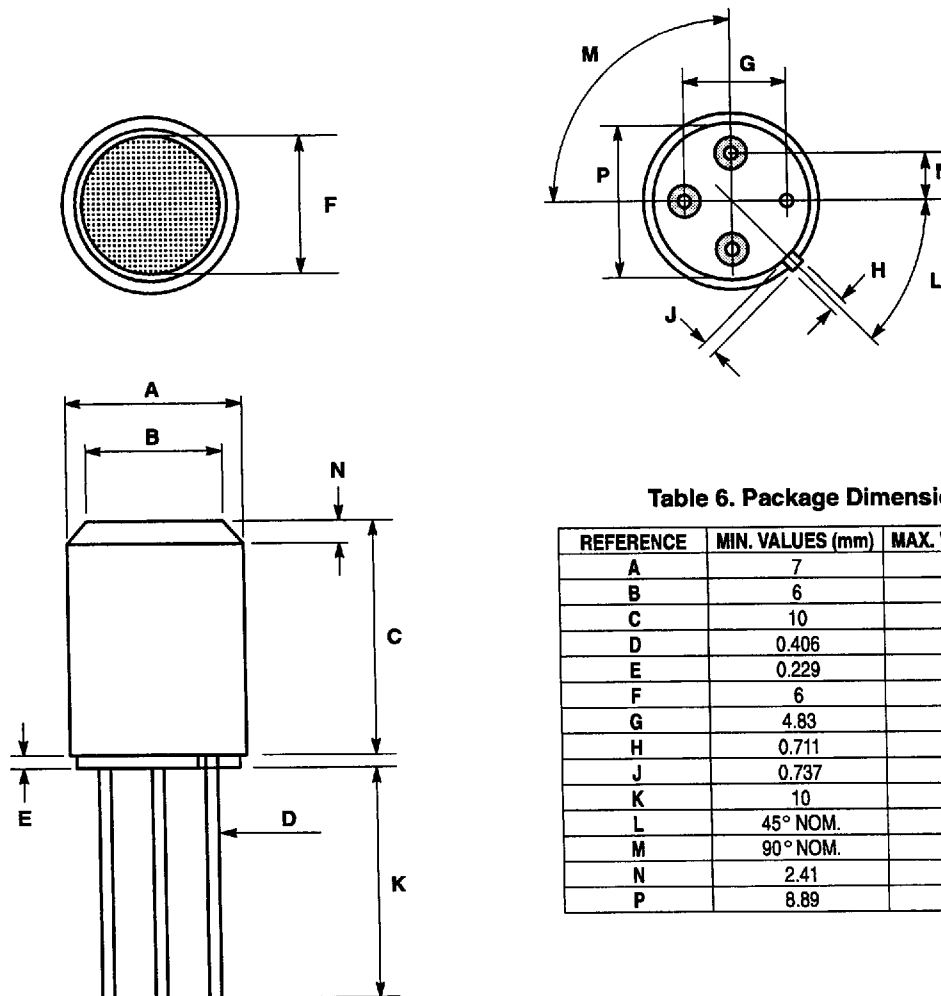


Table 6. Package Dimensions

REFERENCE	MIN. VALUES (mm)	MAX. VALUES (mm)
A	7	13
B	6	9
C	10	16
D	0.406	0.533
E	0.229	2
F	6	12
G	4.83	5.33
H	0.711	0.864
J	0.737	1.02
K	10	14
L	45° NOM.	—
M	90° NOM.	—
N	2.41	2.67
P	8.89	9.40