CARBON MONOXIDE CO SS SOLID STATE ELECTROCHEMICAL SENSORS

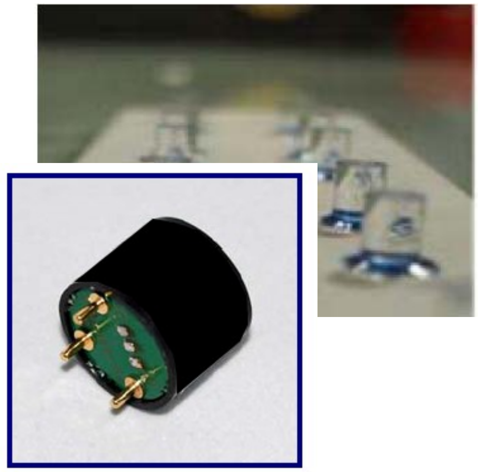
1. DESCRIPTION OF TECHNOLOGY

The CO sensor is based on the technology of electrochemical gas detection principle. This technology can be used to detect chemicals or gases that can be oxidized or reduced in chemical reactions.

Carbon Monoxide:

The following reaction takes place when CO diffuses into the sensor:

CO will generate a reaction where the measurement electrode and the electrolyte are in contact with each other.



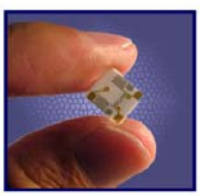
CO SS - 4 Series sensor
Part no. 2112B010440
Standard range: 0-1000ppm
Optional ranges: 0-2000ppm or 0-4000ppm CO

This point is called 3 phase boundary. The following components are active within the electrochemical reaction: H_2O (from natural humidity), CO and the solid electrolyte. These components form 2 H+ ions, CO2 molecule as well as two electrons. The amount of electrons (Energy) is directly proportional to the amount of Carbon Monoxide.

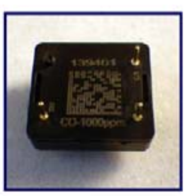
The two Protons (H+) and free Oxygen in the electrolyte will form H_2O at the counter electrode again. The Reference Electrode is isolated and maintains the base potential to stabilise the Sensor output, even when the sensor is exposed to high concentrations of Carbon Monoxide.

Three Electrode Sensors have a wider detection range with good direct linearity.

Oxygen is not needed for the chemical reaction. But this does not mean that the sensor can work in environments without oxygen. An atmosphere without oxygen will cause the free Oxygen inside the Electrolyte to disappear slowly. This process absorbs only the Carbon Monoxide. Since the CO is the fuel for the reaction, the life expectancy of the sensor is almost unlimited.



Raw sensor
part no. 2112B010240



Micro sensor
part no. 2112B012740

5V integrated transmitter
part no. 2112B013440

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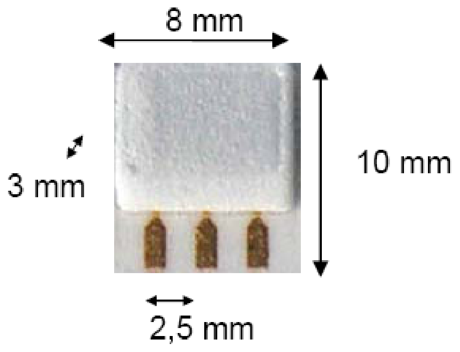
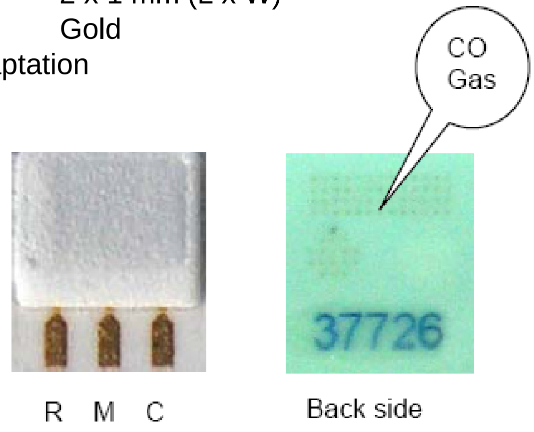
2. DESIGN



Dimensions: 8 x 10 x 3 mm (W x H x D)
Contact distance: 2.5 mm
Contact dimensions: 2 x 1 mm (L x W)
Contact material: Gold
Contact holes for pin adaptation



The target gas enters through a diffusion zone on the back. It is nearly impossible to block the gas from entering the sensor unless the complete surface is blocked.

The electrode on the left is the reference electrode (R).
The middle is the measurement electrode (M).
The right is the counter electrode (C).

The final layers are the electrolyte and the protection cap.

A RAW sensor is part of a wafer board which contains 48 RAW sensors. Every wafer is gas tested prior to shipment. The sensors are separated through pre-manufactured break lines as shown on the next page's illustration. The separation process is very easy if the order is followed carefully.

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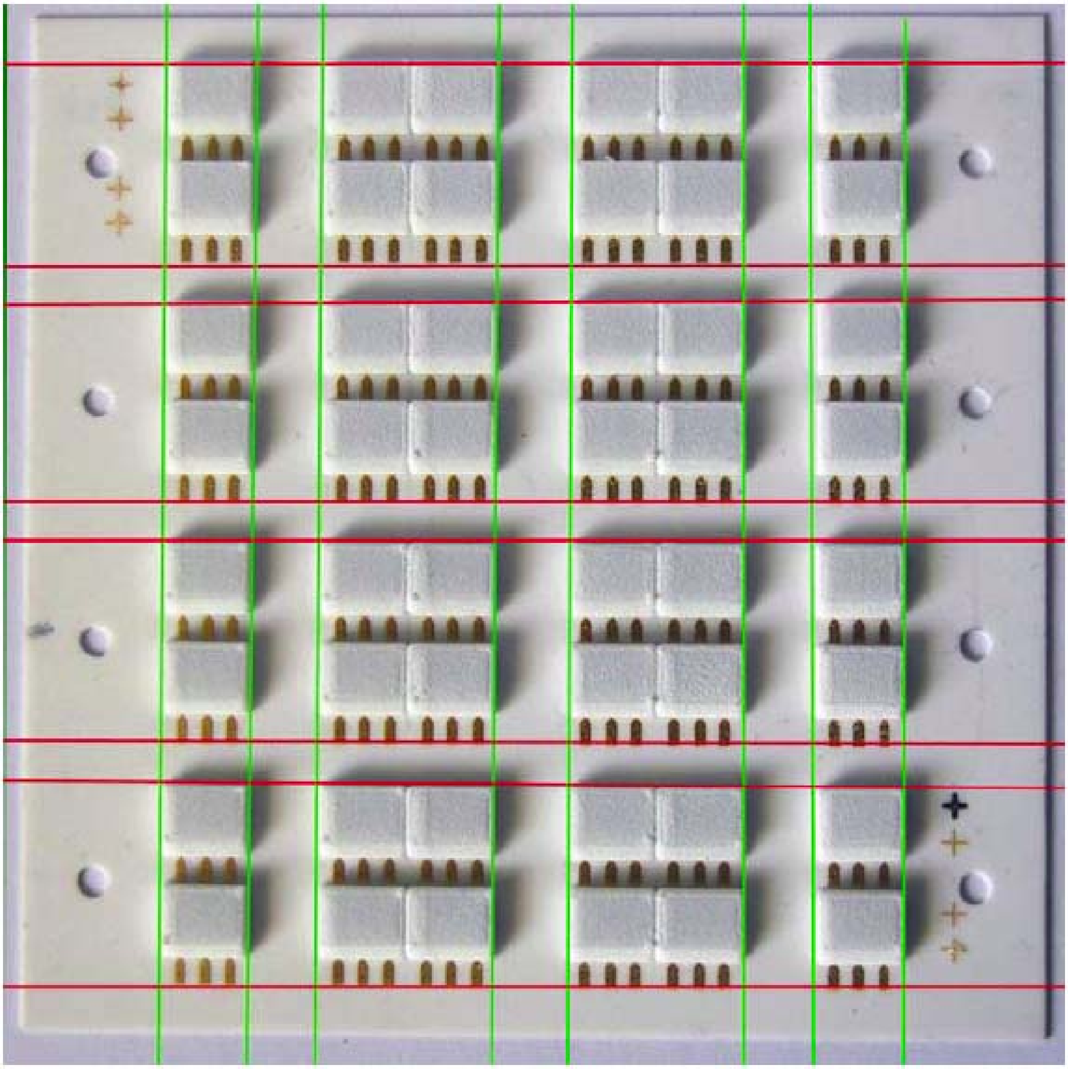
If ordering a wafer of 48 RAW sensors, it is important to break the sensors away from the wafer using the following order:



1. Break the wafer at the **RED** lines first. It is not important which one is used first.
2. Next, break the wafer at the **GREEN** lines.

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3. CHANGES TO THE PREVIOUS ELECTROCHEMICAL SENSORS

a) Acid electrolyte like H_2SO_4 is replaced by a solid electrolyte.

What happens with the previous system?

- ✗ Standard sensors require a sealed housing to protect the surrounding from the aggressive acidic electrolyte.
- ✗ As acid takes in and releases water, there is a risk of leakage in humid atmospheres or a drying out effect in dry atmospheres. Therefore, the biggest part of such a sensor is a reservoir for the acid electrolyte. Acid based sensors are therefore larger due to the need for a large electrolyte reservoir.
- ✗ There is a potential for damage to electronic circuits should the sensor leak.
- ✗ Production of acid based sensors is complicated.
- ✗ Acid is dangerous.

Benefits of the new system:

- ✓ The solid electrolyte is not dangerous and much easier to handle.
- ✓ No housing is needed.
- ✓ No reservoir is needed.
- ✓ The reading is very fast and promptly reacts to gas leaks in the environment.
- ✓ Adjustment to humidity and temperature variation is immediate.

b) Plastic housing is not required - the sensor is built on a ceramic wafer.

What does this mean in the old system?

- ✗ Plastic housing needed to be sealed or glued together. Acid and change of temperature may cause damage to the plastic over time.
- ✗ Sensor construction is more complex, with contacts and pins connected via wires to the electrodes through the housing. The process is risky and can reduce sensor life and quality.

Benefits of the new system:

- ✓ Sensors can be produced in parallel in one production step.
- ✓ Ceramic electrodes and electrolytes can be built up in layers.
- ✓ Production is fully automated, increasing quality and stability.

c) Differences in connection

What happens with the old system?

- ✗ Electrodes are produced separately.
- ✗ The connection is with a platinum wire, which needs to be connected to contact pins.
- ✗ Contact pins must be protected from the acid electrolyte.

Benefits of the new system:

- ✓ The wire and the electrode are printed on layers.
- ✓ The last layer is gold, which can be soldered to directly.

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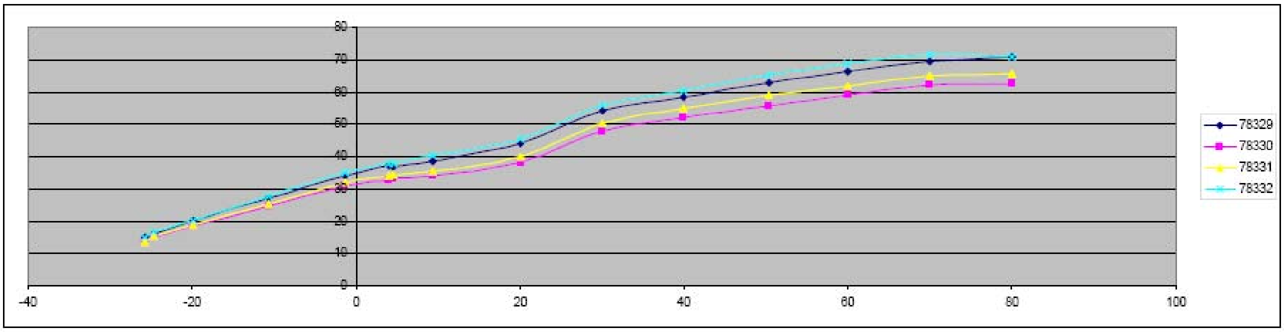
4. TEMPERATURE DEPENDENCY

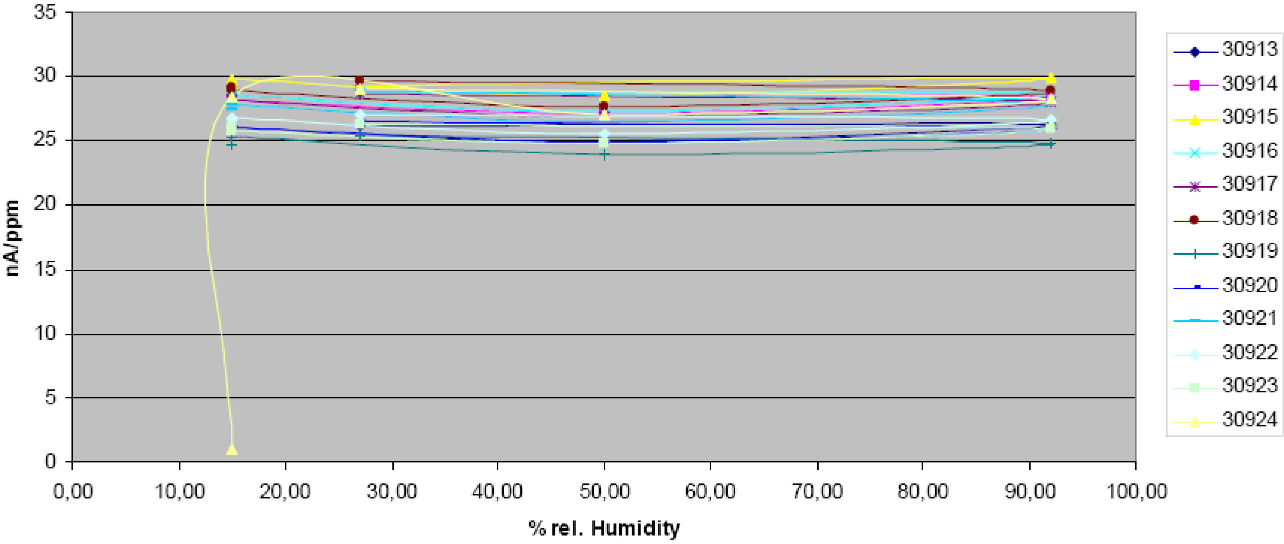
Temperature dependence differs from the common electrochemical sensor. Normally, temperature changes also cause changes in the relative humidity in ambient air. Solid electrolyte sensors adjust immediately to humidity changes. The sensor adapts to the new temperature in minutes.

All materials used for the CO Sensors are suitable for use in temperatures up to 60°C and down to -20°C. However 60°C and very dry air reduce the humidity inside the electrolyte and may result in less sensitivity. The curve below shows the dependency to temperature in controlled humidity.



5. HUMIDITY DEPENDENCE

The standard humidity range for the solid electrolyte sensor is between 10% r.h. and 95% r.h. non-condensing. Water drops cannot block the diffusion opening but may cause a momentary change in behaviour of the sensor. The chart below shows change of sensitivity at different humidity levels and in one hour following humidity change.



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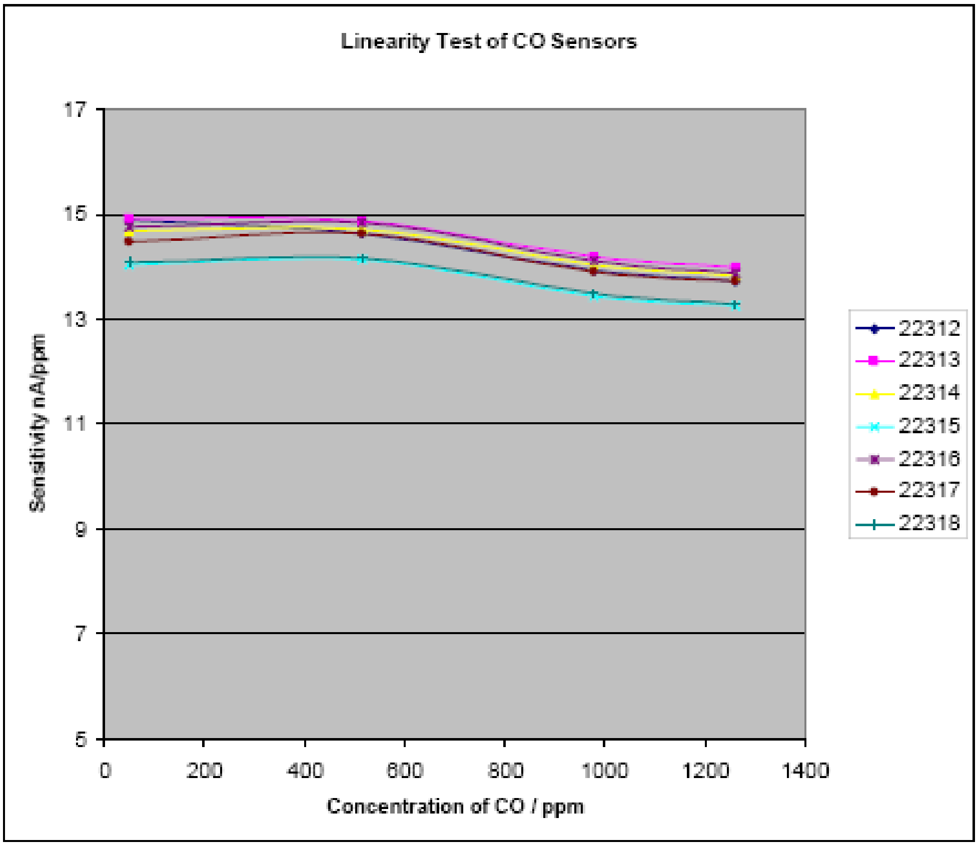
6. LIFE TIME OF THE SENSOR

The Sensor is made of materials that do not have a limited lifetime. There is no poisoning from silicon materials and no consumable materials. Due to the long lasting materials used for the construction of the sensors, aging is not a significant factor.

The standard range sensor 0-1000ppm has a warranty of 2 years from despatch of order. The high range sensor 0-4000ppm has a warranty of 1 year from despatch of order.

7. LINEARITY TEST

The sensor is linear within a wide range, including very high concentrations such as 5000ppm carbon monoxide.



8. CROSS SENSITIVITY

Please see individual sensor datasheets.

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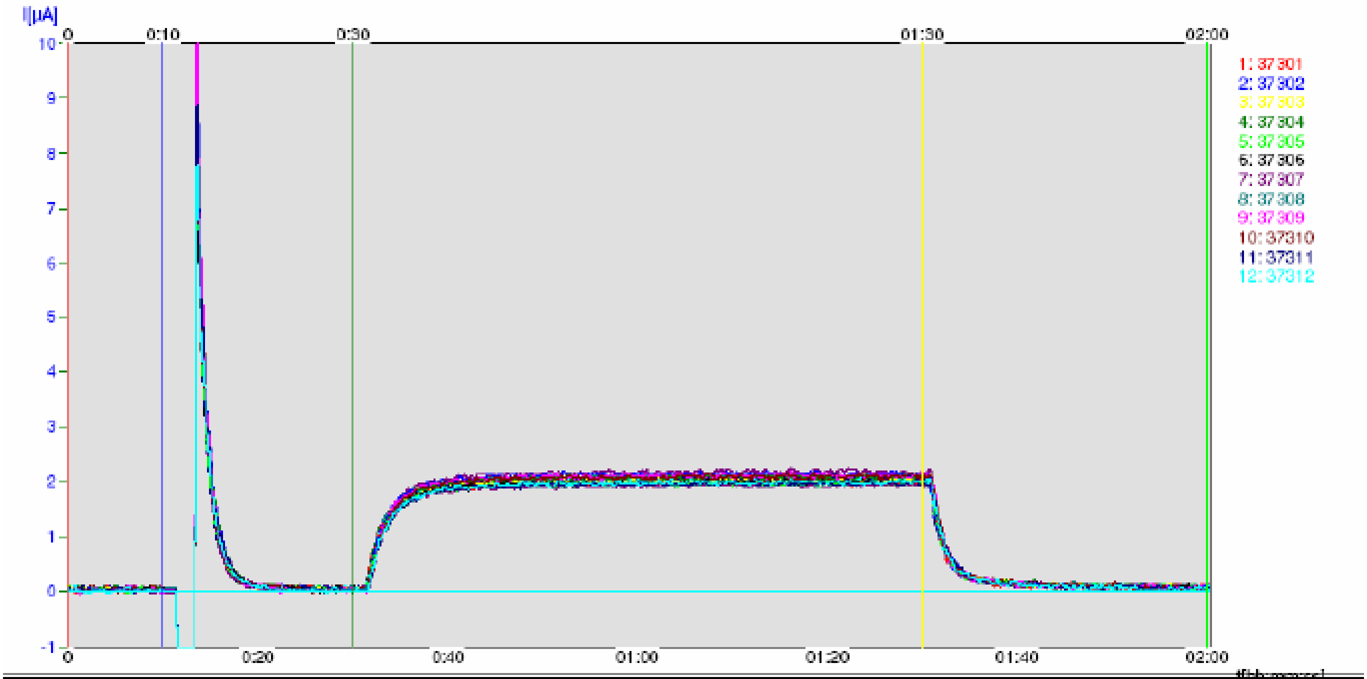
9. SENSITIVITY AND RESPONSE TIME OF SENSORS

The CO Sensor has a bright dynamic range and, due to the solid electrolyte design, a very fast response. Each calibration includes a test gas exposure and capacity test. This test analyses the conductivity/capacity of the sensor and gives correlation to the response time and the sensitivity. The CO sensor has a typical sensitivity of 20nA/ppm and a t90 time of < 15s.



Span gas:	Carbon Monoxide	SPC:	21
Concentration [ppm]:	97,30	Quantity:	48
Temp. coeff. [%/grd]:	0,00	Aging factor:	1,00
PV-No.:	203	Exposing procedure No.:	1
Comment:		Span gas Exposing[sec]:	60
CO Sensors - 20nA/ppm			

Label No.	R	P	Sensor-Bez.	PC	I Start µA	T 50 sec	T 90 sec	I max µA	Empf. nA/ppm	NennE. nA/ppm	CE-Wert ppm/nA	I Ende µA	Status A	M
PC100	1	1	37301	-	0,016	2,8	7,2	2,098	20,63	20,63	484,8	2,023	1	1
PC100	1	2	37302	-	0,054	2,8	6,6	2,125	20,81	20,81	480,4	2,08	1	1
PC100	1	3	37303	-	0,035	2,8	6,6	2,13	21,1	21,1	474	2,087	1	1
PC100	1	4	37304	-	0,025	2,8	7,4	2,148	21,5	21,5	465,1	2,117	1	1
PC100	1	5	37305	-	0,032	2,8	7,6	2,099	20,69	20,69	483,3	2,046	1	1
PC100	1	6	37306	-	0,041	3	7,6	2,018	19,84	19,84	504,1	1,971	0	0
PC100	2	1	37307	-	0,051	3	7,8	2,044	20,12	20,12	497	2,009	1	1
PC100	2	2	37308	-	0,041	2,8	7,2	2,171	21,41	21,41	467,1	2,124	1	1
PC100	2	3	37309	-	0,032	2,8	7,6	2,107	20,99	20,99	476,4	2,074	1	1
PC100	2	4	37310	-	0,033	2,8	7	2,105	20,72	20,72	482,5	2,049	1	1
PC100	2	5	37311	-	0,023	2,8	7,8	2,041	20,3	20,3	492,7	1,998	1	1
PC100	2	6	37312	-	0,042	2,8	7	2,072	20,25	20,25	493,9	2,012	1	1

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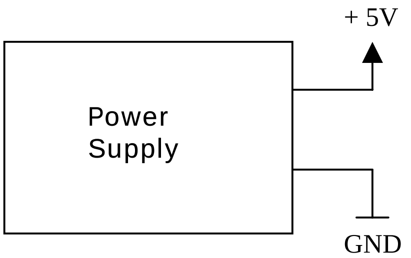
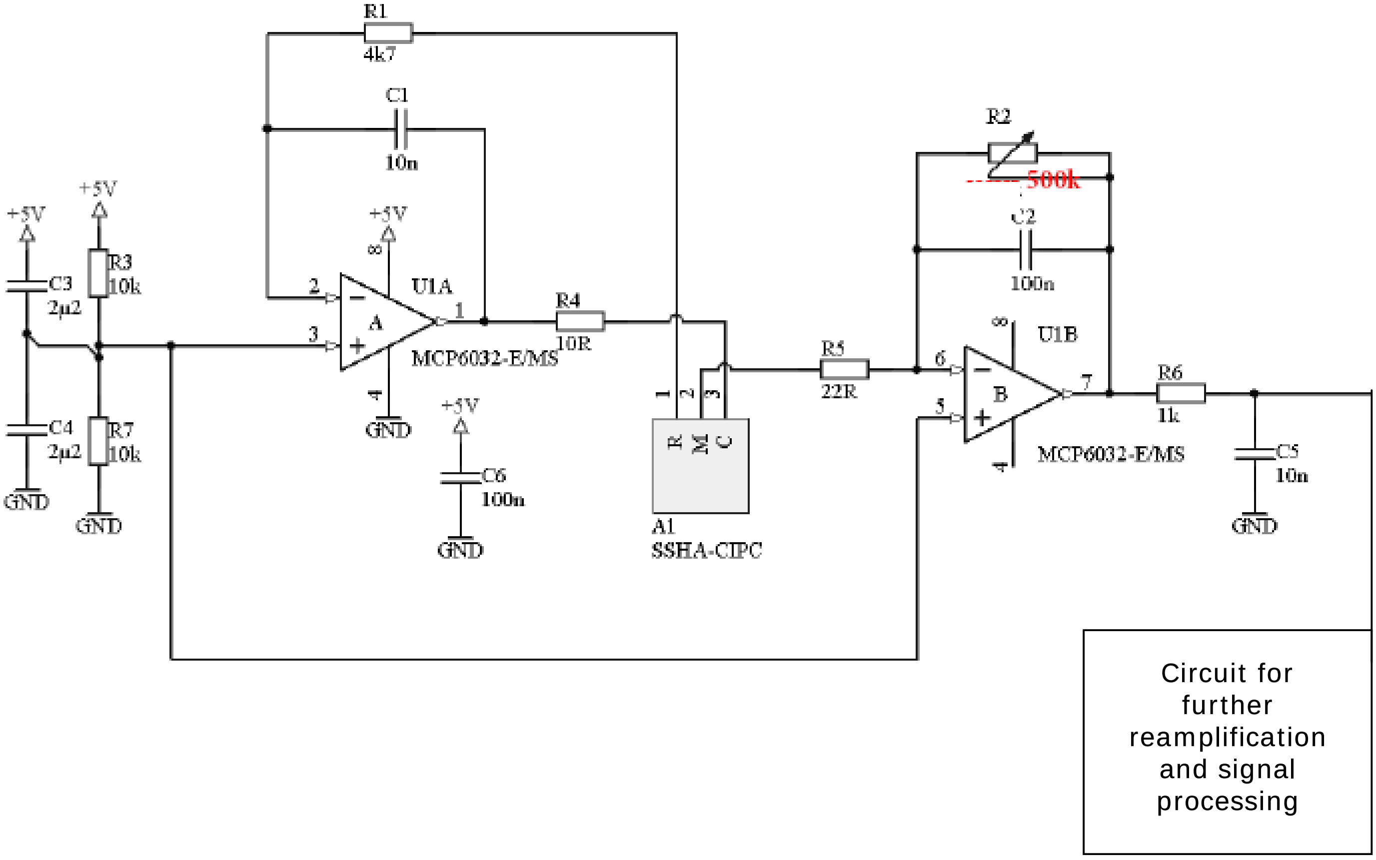
10. EXAMPLE CIRCUIT DIAGRAM



***Note: Do not solder to the pins. Soldering to the sensor should be avoided and will invalidate warranty. Please utilise PCB pin sockets for connection.**



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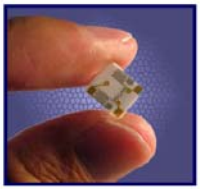
11. SENSOR OPTIONS

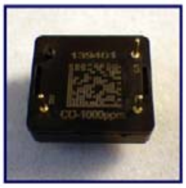
SS solid state sensors are available in different sizes as single sensor options and also complete with precalibrated voltage or i²C-bus transmitter output options; ideal for both small and volume requirements:

<u>Single Sensors</u>

Raw sensor (on board of 48 sensors):



Micro sensor:

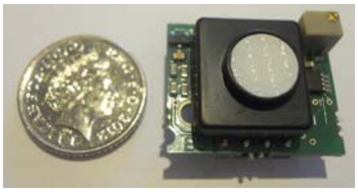


4 Series sensor:

<u>Sensors with Transmitter boards</u>

Sensors with integrated 5V precalibrated transmitter:

Sensors with pluggable 5V or i²C-bus precalibrated transmitter:



<u>Accessories</u>

Adapter board for Micro sensor to convert to standard 4 series pin size:

Micro sensor gas flow cap (fits directly to Micro sensor):

Installation kit for 4 series sensor with integrated 5V transmitter:

4 Series sensor gas flow cap (installation kit required):

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