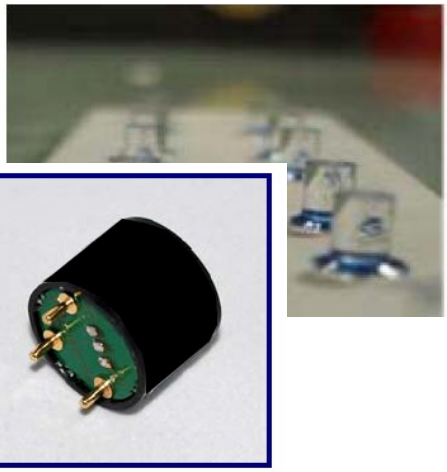
NITROGEN DIOXIDE NO2 SS SOLID STATE ELECTROCHEMICAL SENSOR

1. DESCRIPTION OF TECHNOLOGY

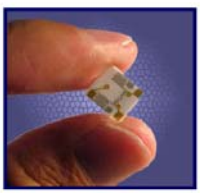
The NO_2 sensor is based on the principle of electrochemical gas detection. This technology is suitable for the detection of gases which can be oxidised or reduced by an electrochemical reactions.

NO_2 diffuses into the sensor and generates at the 3 phase boundary, which is formed by the measurement electrode, the electrolyte and the gas phase, the following process:

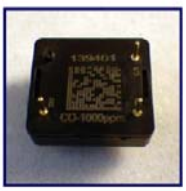
$NO_2 + 2\ H^+ + 2\ e^- \dashrightarrow NO + H_2O$



NO2 SS - 4 Series sensor
Part no: 2112B010450
Range: 0 – 100 ppm



Raw sensor
part no. 2112B010250



Micro sensor
part no. 2112B012750

5V integrated transmitter
part no. 2112B013450

The measured current is directly proportional to the concentration of Nitrogen Dioxide in the air.

The reference electrode is capsulated and maintains the base potential to stabilise the sensor output, even when the sensor is exposed to high NO2 concentrations. Therefore, three electrode sensors have a better dynamic detection range with good linearity in relation to the two electrode sensors.

During this process, Nitrogen Dioxide will be reduced to NO which leaves the sensor. Since there is no consumption of chemicals, life expectancy of the sensor is almost unlimited.

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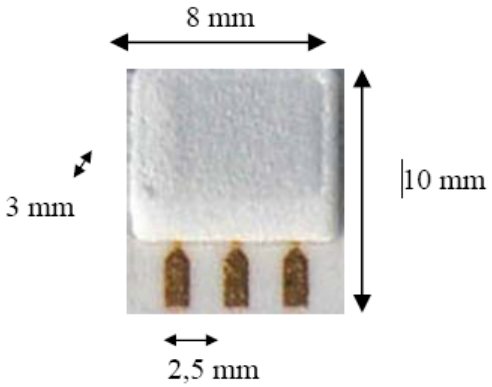
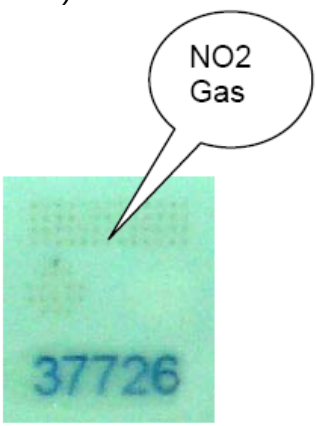
2. DESIGN



Raw sensor
part no. 2112B010250

Dimensions:	8 x 10 x 3 (+/- 0.1) mm (W x H x D)
Contact distance:	2.5 mm
Contact dimensions:	2 x 1 mm (L x W)
Contact material:	Gold
Contact for pin adaptation	

R M C



Back side

The target gas diffuses through a diffusion zone in the ceramic substrate. It is nearly impossible to block the gas from entering into the sensor unless the complete surface is covered, for example, by water.

The left electrode is the reference electrode (R); the middle one is the measuring electrode (M) and the right one 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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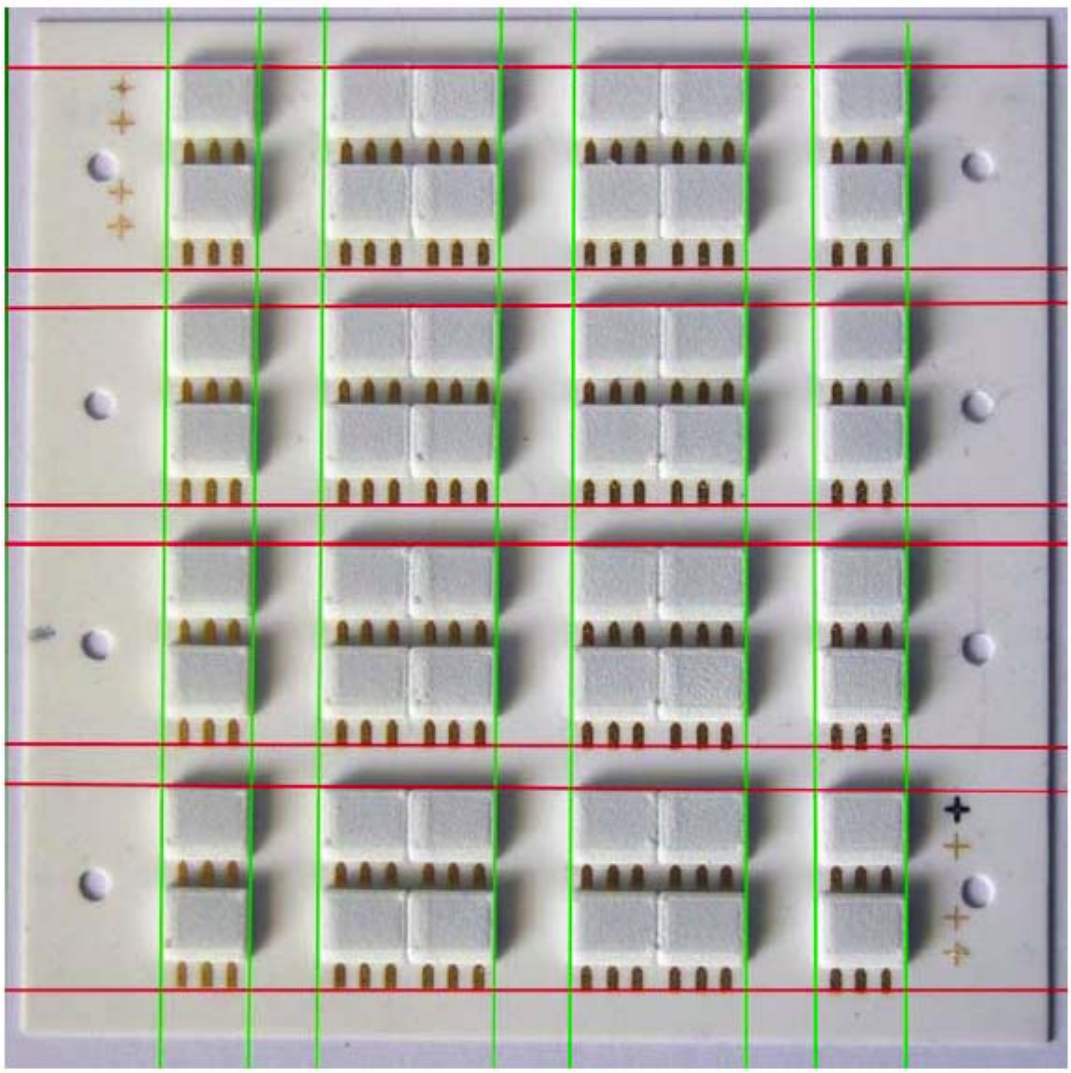
If ordering a wafer of 48 RAW sensors, it is important to break the sensors away from the wafer using the following order:



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 made 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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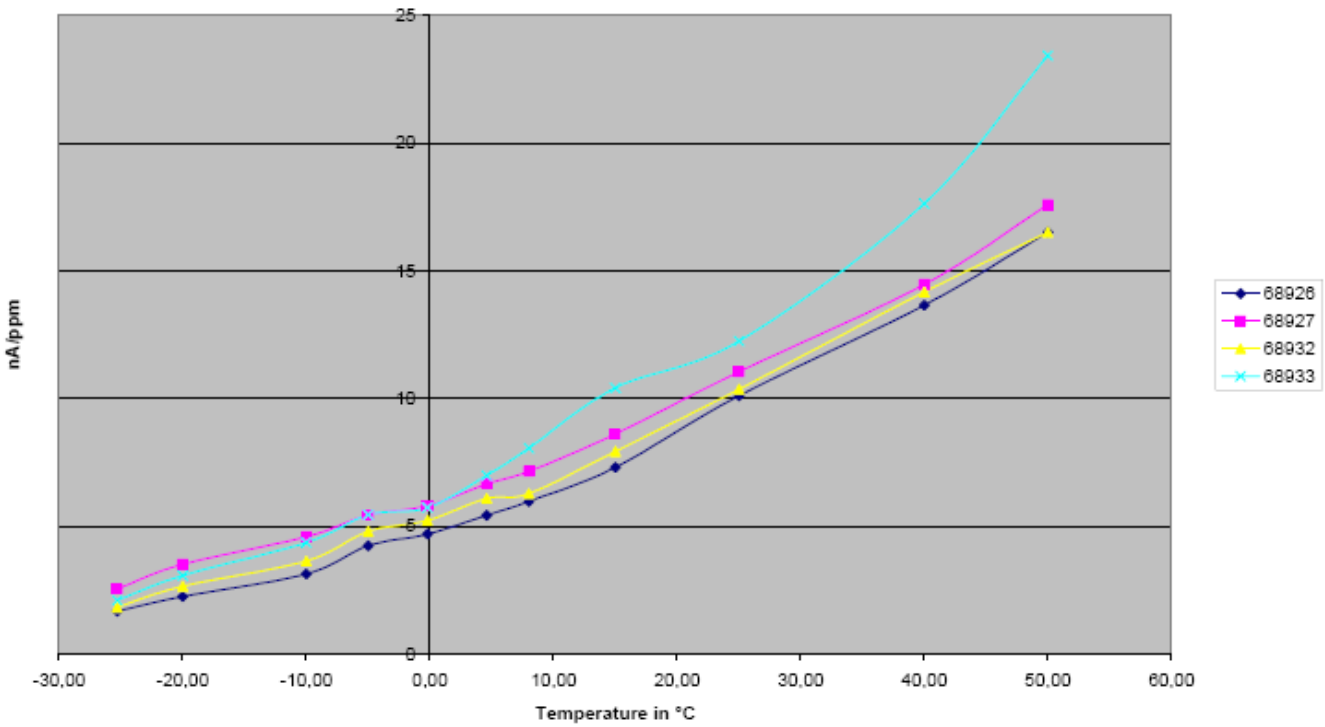
4. TEMPERATURE DEPENDENCY

The temperature dependence differs from common electrochemical sensors. Basically, temperature changes in the ambient air cause changes in the relative humidity. Solid electrolyte sensors adjust immediately to the humidity changes due to the small amount of solid electrolyte. Due to the small volume, it takes only minutes for the sensor to adapt to the new temperature.

All materials of the NO2 Sensors are suitable for the use up to 60°C and down to -20°C. However, 60°C in combination with very dry air will reduce the Proton activity inside of the electrolyte and the sensitivity.

The curve below shows the influence of temperature to the sensitivity under controlled humidity conditions. The temperature coefficient calculated with the data from the chart below is 2,5 – 3 %/°C.



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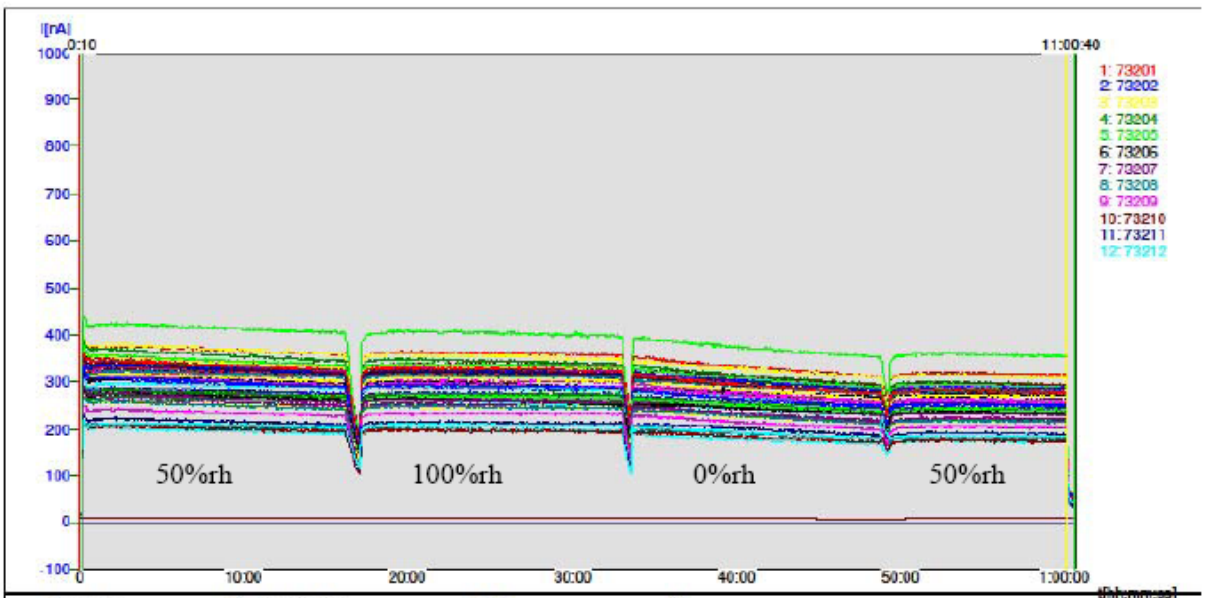
5. HUMIDITY DEPENDENCE

The standard humidity range for the NO_2 solid electrolyte sensor is between 10% r.H. and 95% r.H. Water drops cannot block the diffusion area but may cause a momentary change of the sensor output.

The chart following shows slight influence of the humidity to the sensor reading at 11 ppm NO_2. The humidity was applied for 15 minutes.



Span gas:	Nitrogen Dioxide	**SPC:**	31
Concentration [ppm]:	11,00	**Quantity:**	49
Temp. coeff. [%/grd]:	0,00	**Aging factor:**	1,00
PV-No.:	205	**Exposing procedure No.:**	11
Comment:		**Span gas Exposing[sec]:**	3600
100%			

6. LIFE TIME OF THE NO2 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 sensor warranty is 2 years from despatch of order.

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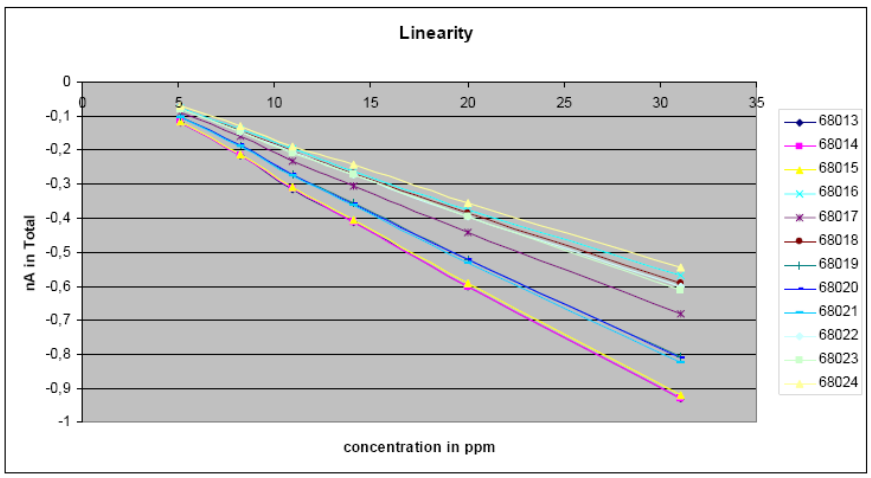
7. LINEARITY TEST

The sensor is linear in a wide range. Even concentration of > 50ppm NO_2 can be handled well.



8. CROSS SENSITIVITY

Please see individual sensor datasheets.

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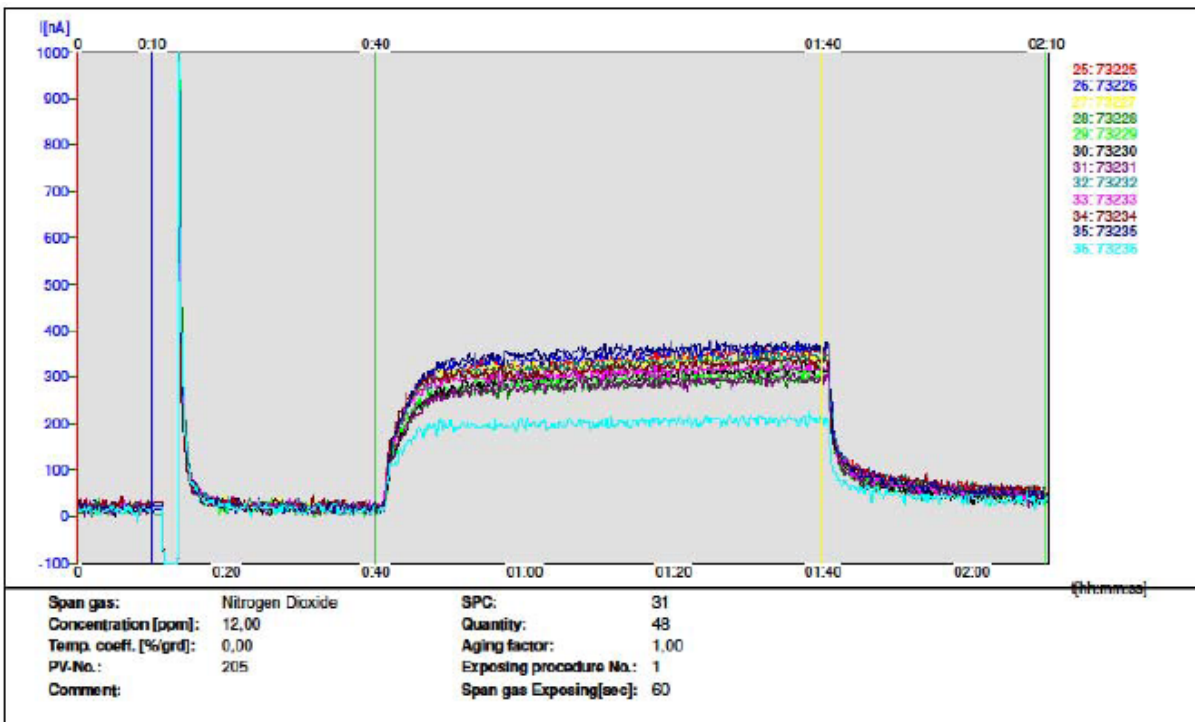
9. SENSITIVITY AND RESPONSE TIME OF NO2 SENSORS

The NO_2 Sensor has a bright dynamic range and, due to the solid electrolyte design, a very fast response, as shown in the response curve below. 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 NO_2 sensor has a typical sensitivity of 20nA/ppm and a t90 time of < 10s.



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	Status M
PC100	1	1	73201	-	0,018	3,4	8,2	0,409	31,27	31,27	319,8	0,394	1	1
PC100	1	2	73202	-	0,015	3,4	9,2	0,342	26,25	26,25	380,9	0,33	1	1
PC100	1	3	73203	-	0,012	2,8	7,6	0,4	31,32	31,32	319,3	0,388	1	1
PC100	1	4	73204	-	0,021	3,2	7,6	0,392	29,45	29,45	339,6	0,374	1	1
PC100	1	5	73205	-	0,018	3,2	9,4	0,467	36,49	36,49	274	0,456	1	1
PC100	1	6	73206	-	0,017	3	9,6	0,352	27,02	27,02	370,2	0,341	1	1
PC100	2	1	73207	-	0,017	3,4	10,2	0,287	21,63	21,63	462,3	0,276	1	1
PC100	2	2	73208	-	0,022	3	9	0,361	27,28	27,28	366,5	0,349	1	1
PC100	2	3	73209	-	0,027	2,6	8,6	0,364	27,01	27,01	370,2	0,351	1	1
PC100	2	4	73210	-	0,014	3	10,4	0,387	29,48	29,48	339,2	0,368	1	1
PC100	2	5	73211	-	0,021	3,2	9	0,379	28,46	28,46	351,3	0,363	1	1

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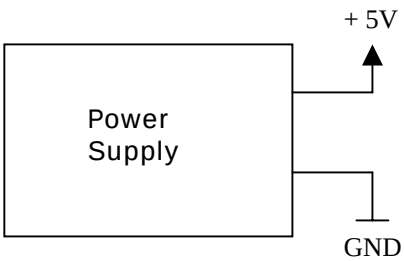
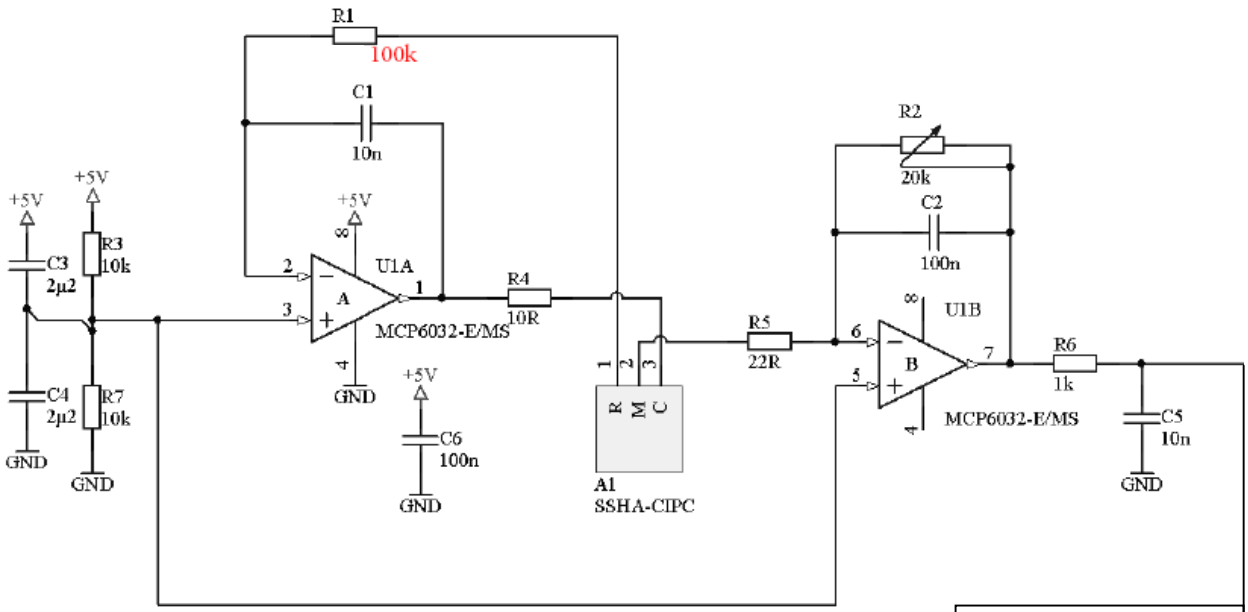
10. EXAMPLE CIRCUIT DIAGRAM



***Note: Do not solder to the element contacts/pads. Soldering to the sensor should be avoided and will invalidate warranty.**

Raw sensors should be treated with care and can easily be damaged. Adapter type housing is recommended. For initial trial and test purposes, we recommend the 'Micro' version SS sensors.



Circuit for further reamplification and signal processing

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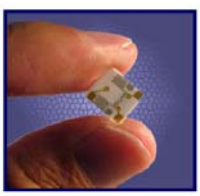
11. SENSOR OPTIONS

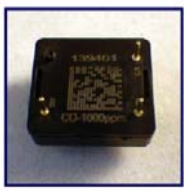
SS solid state sensors are available in different sizes as single sensor options and also complete with precalibrated voltage or i²C-bus transmitter output options; ideal for both small and volume requirements:

Single Sensors

Raw sensor (on board of 48 sensors):



Micro sensor:

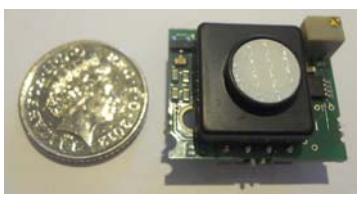


4 Series sensor:

Sensors with Transmitter boards

Sensors with integrated 5V precalibrated transmitter:

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



Accessories

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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