

- 1 *Capacitive pressure sensor ASIC.*
- 2 *Standard pressure gauge.*

## INTEGRATED CAPACITIVE PRESSURE SENSORS

- **INTEGRATED MINIATURE SOLUTION**
- **LOW POWER CONSUMPTION**
- **TRANSPONDER CAPABILITY**

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Pressure is one of the most frequently measured quantities. In automotive, industrial, consumer or medical applications pressure sensors with various requirements are in use. Surface  $\mu$ -machined capacitive pressure sensors offer advantageous features.

### Capacitive sensing principle

A micro »plate capacitor« with a thin diaphragm deflecting under pressure as depicted in Figure 1 is appropriate for the detection hereof. The sensor capacitance is a function of the distance between the top polysilicon and the bottom n+ doped silicon electrode which varies with the applied pressure.

### CMOS compatible processing

An elegant and reliable method to fabricate this kind of sensing elements is the technique of surface  $\mu$ -machining which is fully compatible to CMOS processing. This key feature enables the integration of sensing elements and signal conditioning electronics on one chip as shown in Figure 2. A high voltage option and the integration of an EEPROM for data storage are also available.

### High temperature option

Using SOI wafers (silicon on insulator) instead of bulk silicon a high temperature option has been implemented, too. Both pressure sensing element and on chip SOI CMOS readout circuitry operate reliably at temperatures up to +250°C as shown in Figure 5.





### Further sensor features

- **Absolute pressure sensor**

Sealing the micro structure under vacuum condition results in an absolute pressure sensor cell as the reference pressure in the cavity is vacuum.

- **Design controlled sensing range**

The pressure range is design controlled by adjusting the diameter of the diaphragm while keeping the thickness to be fixed. Layouts for ambient pressure operation up to 350 bar are available.

- **High overpressure stability**

The small cavity height limits the deflection of the diaphragm automatically, once the top plate touches the bottom at the so-called contact pressure, resulting in high overpressure stability.

- **Low power consumption**

In order to readout the small capacitance of the pressure sensor cell small currents are needed to charge or discharge the capacitor. Combining this with CMOS circuitry systems with a total power consumption below 150  $\mu$ W are available.

- **Low temperature dependence**

Reference sensor cells can be fabricated next to the sensing elements by leaving the thick passivation layer on top of the diaphragm. By the use of sensor/reference concepts parasitic influences and also the temperature dependence of the device can be drastically reduced.

- **Batteryless sensor transponder**

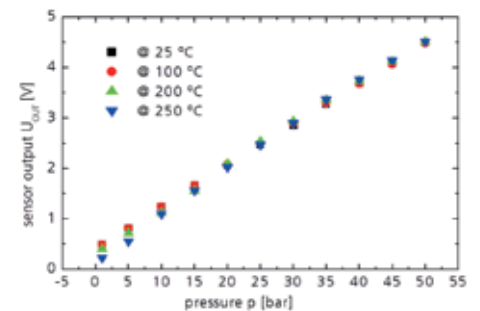
Combining the low power feature and the monolithic integration of CMOS circuitry single-chip sensor transponders have been achieved including on chip temperature sensing.

### Applications

Due to its unique selling points »small«, »low power«, and »wireless« IMS pressure sensor technology is ideally suited for a variety of applications from implantable pressure sensing devices in medicine, tire pressure monitoring in automobile to hydraulic and vacuum isolation measurement as illustrated in Figure 6. All shown examples of devices have been developed in contract research for industrial customers.

### IMS services

Combining the know-how for mixed signal circuit design, sensor technology and system design IMS offers customized system solutions covering the full range from concept, feasibility study to first sample development and prototyping, ending up with pre-series and series production of the sensor ASICs. A modern 8" fab working at four shifts ensures the production of the microchips. In accordance with the policy of wtechnology transfer the patented pressure sensor IP can be licensed.



3 Example for telemetric readout.

4 Sensor array.

5 High temperature sensor output.