Application Note: Hydrostatic wireless and battery-less SAW pressure sensor

In this note an original application of SAW technologies is presented :
A liquid level is detected by the way of its hydrostatic pressure.

Sensor

Here we illustrate a pressure and temperature sensor that we have developed for other application. This sensor contains three resonators : reference, pressure (on the diaphragm inside the circle) and temperature (Figures 1 and 2).

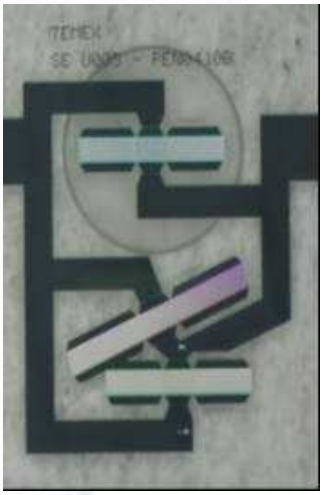

FIG. 1 – The chip.

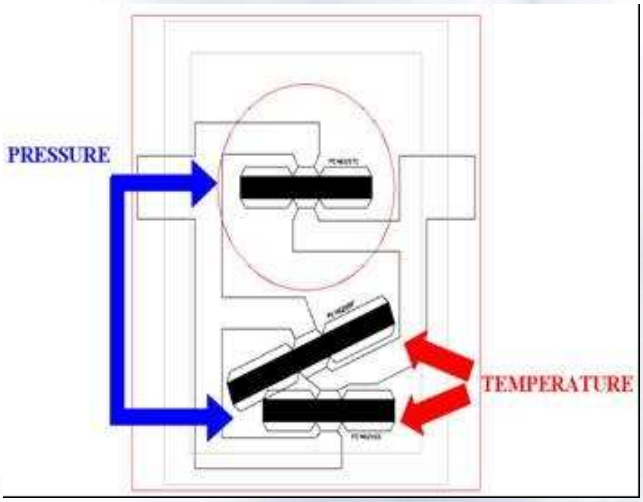

FIG. 2 – The resonators.

This chip was developed to resist pressure up to 6 bars. We have a trade-off between the measurement range and the resolution requested. To increase the resolution we need to slim and/or increase the area of the membrane on which the pressure is applied - but these actions imply a reduction of sensor pressure range.

The shown sensor has a sensibility of 30 kHz per bar which is equivalent to 300 Hz per 10 mbar - and so 300 Hz for a variation of 10 cm level of water (we immerse the sensor in a tank filled of water : Figure 4).

Tests

We have immersed the sensor (Figure 3) in the water (Figure 4) and measured the sensibility of the SAW to the hydrostatic pressure.

FIG. 3 – SAW sensor mounted on its connector.

FIG. 4 – Immersed sensor.

The results (frequency shift versus depth) are illustrated on Figure 5. From them we calculate a experimental sensibility of 3.5 kHz by meter (equivalent to 3.5 kHz by 100 mbar). An experimental sensitivity of 3.5 kHz per meter is obtained from those results, which is equivalent to 35 kHz per bar. It confirms our predictions to 30kHz per bar.

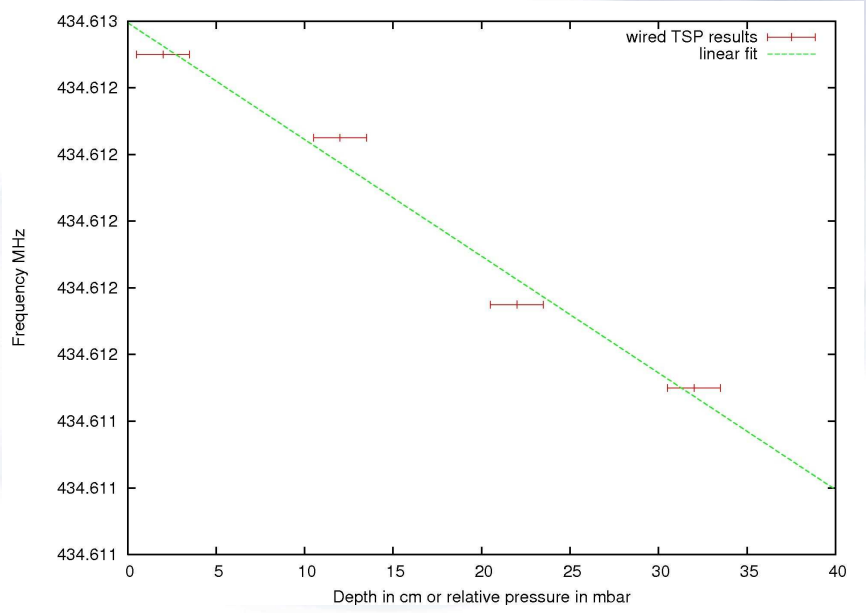

FIG. 5 – Measurement results (wired).

The main factor which impacts the detected level of pressure is the interrogator resolution. With 350 Hz resolution interrogation we get 10 mbar resolution : we are able to measure a variation of liquid height of 50 cm to 10 cm depend of the wireless configuration (see sample antenna connected to the sensor on Figure 6).

Fig. 6 – Antenna connected to the sensor.

Conclusion

We have demonstrated the possibility to interrogate our wireless sensor immersed in a liquid (in these tests water has been used but any non polar liquid as hydrocarbon would work). This application allowed detecting water level variations of 10cm - of course can we develop systems for different specifications.

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