

Barometric pressure sensor and use cases

Product
DPS310

About this document

Scope and purpose

This document provides an overview of barometric pressure sensing, digital air pressure sensor and use cases.

Intended audience

The document is intended for Infineon customers who wish to develop applications based on DPS310 barometric pressure sensor.

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1 Air pressure overview

1 Air pressure overview

Barometric pressure is the force exerted by the atmosphere at a given point against an object. Fluctuations in barometric pressure are usually a sign of changing weather conditions. Barometric pressure will also vary with altitude and moisture.

Static pressure is the pressure you have if the air isn't moving or if you are moving with the air. Dynamic pressure is the pressure of air that results from its motion. Air wouldn't press against you equally in all directions. It decreases with an increase in speed because of conservation law. Total air pressure, static and dynamic, is what acts on you as you face into the wind and the air collides with your body.

DPS310 is part of environmental sensors family and it can measure air pressure. It is suited for measuring dynamic air pressure or static air pressure. This makes the barometric pressure sensor suitable for motion monitoring like sport, fitness activities and also for altitude metering, drones and indoor navigation.

Figure 1 Human body motion, weather and wind speed change the air pressure

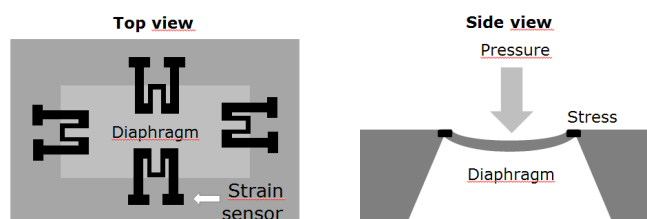


2 Air pressure sensing

Different methods are used to measure the air pressure and calculate altitude or wind speed. Advanced motion monitoring applications have been developed based on dynamic air pressure sensing.

Micro-Electro-Mechanical-System (MEMS) technology is used to produce small form factor sensors for measuring air pressure. The air pressure can be monitored based on piezo-resistive effect. The mechanical stress into diaphragm generated by air force relative to a reference pressure cavity cell under the diaphragm. This is described in the picture below.

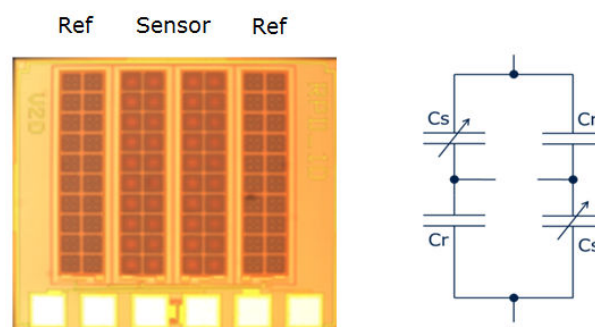
Figure 2 Piezo-resistive sensor operating principle



These type of sensors are quite popular in the portable weather stations market where barometric pressure resolution in mBar is enough. These type of sensors have nonlinear temperature response and require more complex calibration. Also, due to high pressure noise level, these sensors cannot cover all applications which require low pressure noise, fast transient response, temperature stability and low power.

Capacitive MEMS technology offers excellent pressure noise, very good pressure accuracy and low power. The capacitive pressure sensing cell is shown in the picture below:

Figure 3 Capacitive pressure sensing cell structure and bridge configuration



This technology offers better performance in motion tracking applications. The pressure measurement is a differential measurement between sensing and reference cells which offer better temperature stability and low pressure noise. The power consumption on the sensor cell is 50% or less than resistive type of sensor cell bridge. Advanced motion detection applications can utilize the capacitive sensor technology. It is possible to detect body movements like walking or climbing by using only a pressure sensor.

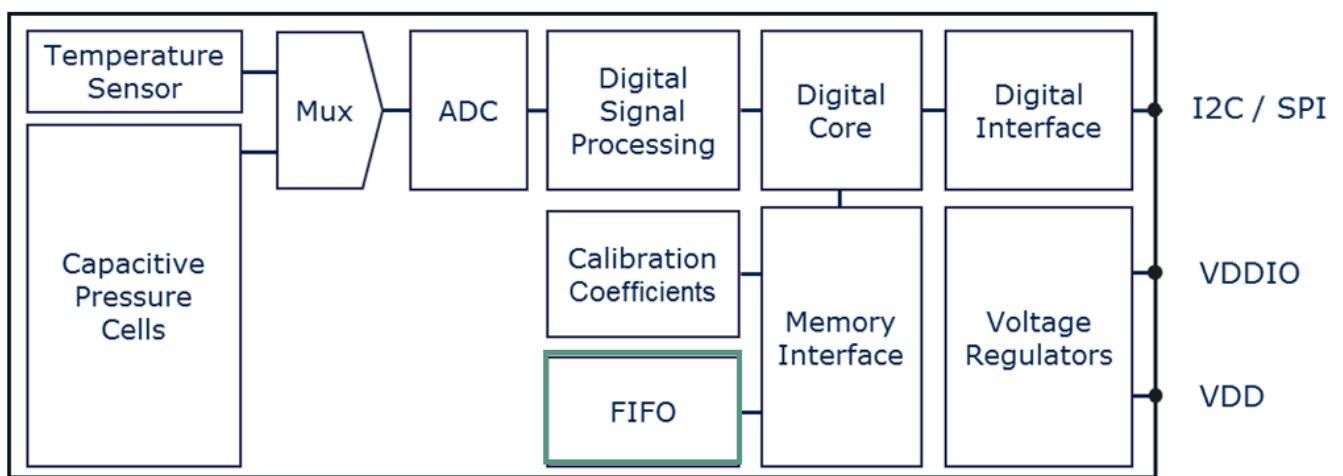
3 Digital barometric pressure sensor for motion, advanced architecture

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DPS310 is a digital barometric pressure sensor based on capacitive MEMS technology for optimal operation in variable environmental conditions. Every sensor is individually calibrated in production line and the calibration coefficients are stored in a sensor One-Time-Programmable (OTP) Memory to achieve best pressure noise performance.

DPS310 architecture is optimized to achieve high pressure measurement accuracy and offer a FIFO type measurements data buffer. The sensor architecture is presented in the picture below:

Figure 4 DPS310 barometric pressure sensor block diagram



The pressure calculation formula can be customized on system level. The compensated values are calculated in the host device and algorithms such as filters can be modified easily. More details about pressure calculation formula, measurements rates and pressure noise are available in the DPS310 datasheet.

4 IIR filtering

4 IIR filtering

Infinite impulse response (IIR) is a property applying to linear time-invariant system like atmospheric air. The IIR filtering enable air pressure sensing applications to distinguish between different type of air turbulence generated by weather, fitness activities, etc.

Software realization of the Low Pass IIR filter can be like below:

Output = history + filter_coeff * (current_sample - history)

history = previous output

The change from one filter output to the next is proportional to the difference between the previous output and the next input

Where filter_coeff will determine filter decay-ramp up time and proportionality/weightage to deviation from history

Similar, the software realization of the High Pass II filter can be like below:

Output = filter_coeff * (history + current_sample - previous_sample)

-A large filter_coeff implies that the output will decay very slowly but will also be strongly influenced by even small changes in input. A small filter_coeff implies that the output will decay quickly and will require large changes in the input (i.e., $(x[i] - x[i-1])$ is large) to cause the output to change much

The IIR filtering implementation on the software application level offer advantages of simplicity, flexibility and customization. This will enable DPS310 to be used simultaneously by different software applications like altitude metering, weather station and sport activities.

5 Use cases

Drones driven by automatic pilot become popular due to high accuracy and fast transient response of the barometric pressure sensors. We can find now in the market drones flying at fixed point and taking pictures. DPS310 can be operated at 32 measurements per second and offering 10cm height tolerance stability in the context of fast transient response and variable ambient temperature. The picture below is showing a micro-drone equipped with automatic pilot and camera for surveillance.

Figure 5 Surveillance drone driven by automatic pilot based on capacitive barometric pressure sensor DPS310



Wearable devices are equipped now with sensors for monitoring sport activities. Accelerometer is the most popular sensor for steps counting and current consumption is less than 1.5mA. For professional users the battery life time can be an issue. DPS310 can sense the air turbulence generated by human body when walking or running. Also it can distinguish between stepping and climbing up and down due to dynamic monitoring of static barometric pressure and also dynamic air pressure. All sensing activity is doable at less than 0.35mA current consumption on the sensor level. The picture below is showing a smart-watch equipped with sensors for sport and fitness activities tracking. DPS310 can run in background mode in full speed and different software applications will compile the readout data and show absolute altitude, relative altitude, elevation of the starting point, step counting, etc.

Figure 6 Wearable devices equipped with sensors for sport activities tracking



Smart clothes, shoes and other accessories industries are expected to offer in the future new products for sport, fitness and well-being. Capacitive sensing technology is offering the solution for the applications involving human body motion.



Figure 7 Capacitive air pressure technology for motion

6 Related links and support material

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A selection of useful internet shortcuts.

- Power Management selection guide
 - <http://www.infineon.com/powermanagement-selectionguide>
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