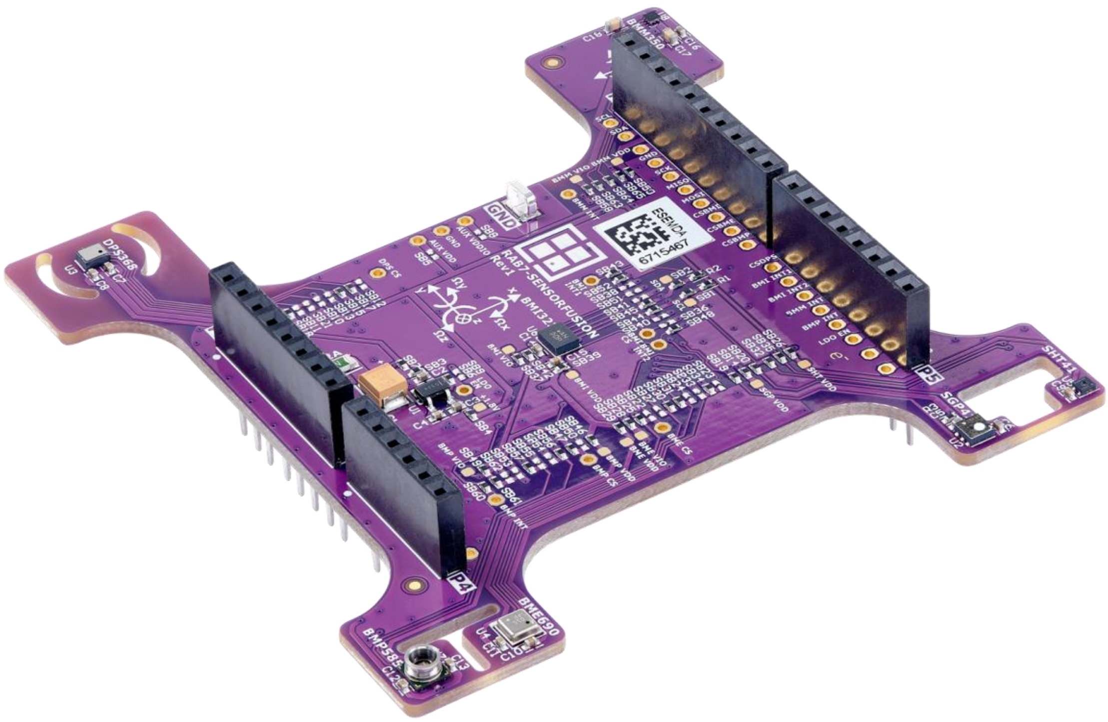
Altitude measurement with Infineon`s DPS368 sensor

Application note



Versions

Version	Date	Rationale
1.0	January 13, 2026	First release. Author: ROJ, KOA

Legal disclaimer

The evaluation board is for testing purposes only and, because it has limited functions and limited resilience, is not suitable for permanent use under real conditions. If the evaluation board is nevertheless used under real conditions, this is done at one’s responsibility; any liability of Rutronik is insofar excluded.

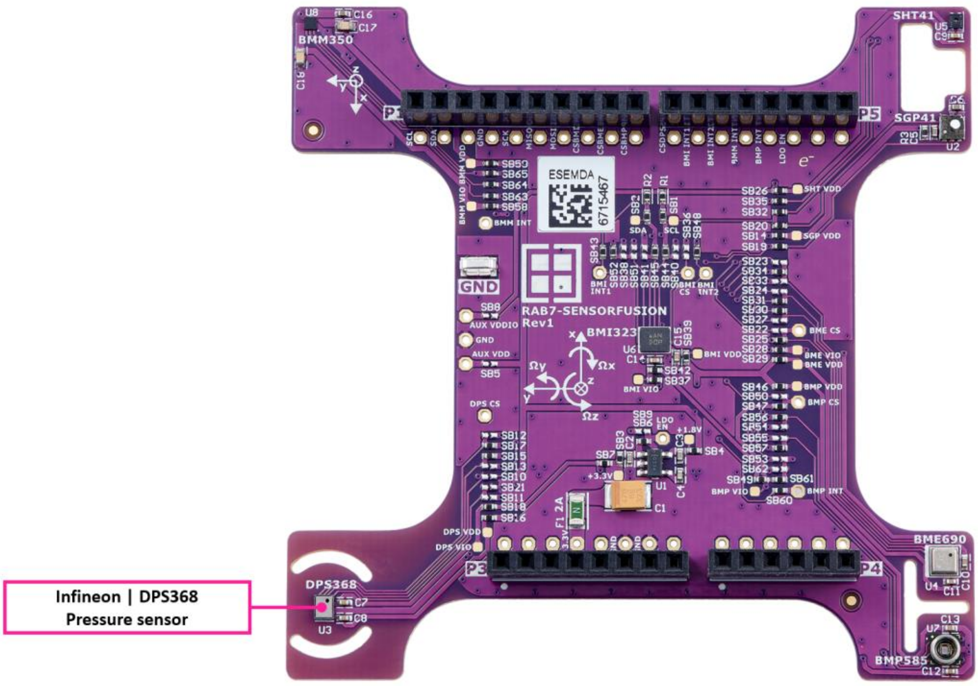
Table of contents

Introduction

This document describes the calculations in a project aimed at measuring the altitude/height of a device in a room (i.e. a closed environment). Another objective was to verify the accuracy of the sensors in these conditions.

Hardware used

The measurements were proceeded by XENSIV™ DPS368 by Infineon integrated into the RAB7-Sensorfusion by System Solutions.



DPS368 is an ultra small waterproof pressure sensor, environmentally protected against water (IPx8), dust & humidity.

Its accuracy specifications:

Relative accuracy: ± 0.06 hPa (or ±0.5 m)

Absolute accuracy: ± 1 hPa (or ±8 m)

Precision: ± 0.002 hPa (or ±0.02 m)

From Pa / hPA into altitude

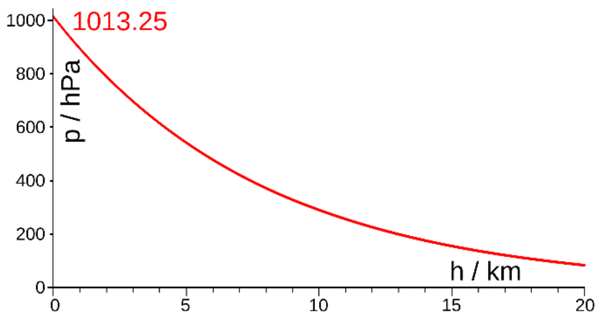
The barometric levelling formula for a linear temperature variation:

$$p = p0 * \left(1 - \frac{a * \Delta h}{T0}\right)^{5,255}$$

With (in application to our project):

- p: the pressure measured by the DPS368 in Pa at the altitude of the device
- p0: the atmospheric pressure at sea level in Pa; p0 = 101325 Pa
- a: vertical gradient of temperature; a = 0.0065 K / m
- T0: temperature at the average state; T0=288,15 K.

And its graphical representation - average atmospheric pressure curve as a function of altitude at constant atmospheric temperature.



This equation gives us the formula for the object altitude based on pressure measured by DPS368:

$$\Delta h = 44330 * (1 - \left(\frac{p}{p0}\right)^{\frac{1}{5.255}})$$

Sensor configurations

Influence of the configuration

The sensor has three configurations connected to the use cases:

- Weather station (lowest resolution),
- Indoor navigation (medium resolution),
- Sport (highest resolution).

Here are the screenshots from the datasheet of DPS368 (page 18/44):

5 Applications

5.1 Measurement Settings and Use Case Examples

Table 10 Measurement Settings and Use Case Examples (TBD)

Use Case	Performance	Pressure Register Configuration Address: 0x06	Temperature Register Configuration Address: 0x07	Other
Weather Station (Low power)	5 Pa precision. 1 pr sec. 3 uA	0x01	0x80	Start background measurements (addr 0x08)
Indoor navigation (Standard precision, background mode)	10 cm precision. 2 pr sec. 22 uA	0x14	0x90	Enable P shift (addr 0x09) Start background measurements (addr 0x08)
Sports (High precision, high rate, background mode)	5 cm precision 4 pr sec. 200 uA	0x26	0xA0	Enable P shift (addr 0x09) Start background measurements (addr 0x08)

PRS_CFG **Address:** 06_H

Pressure measurement configuration **Reset value:** 00_H

7	6	5	4	3	2	1	0
-	**PM_RATE[2:0]**			**PM_PRC[3:0]**			
-	rw			rw			

Field	Bits	Type	Description
-	7	-	Reserved.
PM_RATE[2:0]	6:4	rw	Pressure measurement rate: 000 - 1 measurements pr. sec. 001 - 2 measurements pr. sec. 010 - 4 measurements pr. sec. 011 - 8 measurements pr. sec. 100 - 16 measurements pr. sec. 101 - 32 measurements pr. sec. 110 - 64 measurements pr. sec. 111 - 128 measurements pr. sec. *Applicable for measurements in Background mode only*
PM_PRC[3:0]	3:0	rw	Pressure oversampling rate: 0000 - Single. (Low Precision) 0001 - 2 times (Low Power). 0010 - 4 times. 0011 - 8 times. 0100 *)- 16 times (Standard). 0101 *) - 32 times. 0110 *) - 64 times (High Precision). 0111 *) - 128 times. 1xxx - Reserved

The performance (precision) is mainly affected by the measurement rate (number of measurements per 1 second) and oversampling rate (the number of measurements between the moments when the sensor delivers pressure information).

Weather station – Low resolution

Pressure register configuration = 0x01	Temperature register configuration = 0x80
PM_RATE = 0 → 1 measurement/second PM_PRC = 1 → oversampling 2 times	TMP_EXT = 1 TMP_RATE = 0 → 1 measurement/second TMP_PRC = 0 → No oversampling

Source code

```
xensiv_dps3xx_config_t dps368_config =
{
    .dev_mode               = XENSIV_DPS3XX_MODE_BACKGROUND_ALL,
    .pressure_rate          = XENSIV_DPS3XX_RATE_1,
    .temperature_rate       = XENSIV_DPS3XX_RATE_1,
    .pressure_oversample    = XENSIV_DPS3XX_OVERSAMPLE_2,
    .temperature_oversample = XENSIV_DPS3XX_OVERSAMPLE_1,
    .data_timeout           = 1000,
    .i2c_timeout            = 500,
};
```

Debug output

```
_xensiv_dps3xx_set_temperature_config
Content of register 7 -> 0x80
_xensiv_dps3xx_set_pressure_config
Content of register 6 -> 0x0
_xensiv_dps3xx_set_pressure_config
Content of register 6 -> 0x1
```

Indoor navigation – Medium resolution

Pressure register configuration = 0x14	Temperature register configuration = 0x90
PM_RATE = 1 → 2 measurements/second PM_PRC = 4 → oversampling 16 times	TMP_EXT = 1 TMP_RATE = 1 → 2 measurements/second TMP_PRC = 0 → No oversampling

Source code

```
xensiv_dps3xx_config_t dps368_config =
{
    .dev_mode               = XENSIV_DPS3XX_MODE_BACKGROUND_ALL,
    .pressure_rate          = XENSIV_DPS3XX_RATE_2,
    .temperature_rate       = XENSIV_DPS3XX_RATE_2,
    .pressure_oversample    = XENSIV_DPS3XX_OVERSAMPLE_16,
    .temperature_oversample = XENSIV_DPS3XX_OVERSAMPLE_1,
    .data_timeout           = 1000,
    .i2c_timeout            = 500,
};
```

Debug output

```
_xensiv_dps3xx_set_temperature_config
Content of register 7 -> 0x90
_xensiv_dps3xx_set_pressure_config
Content of register 6 -> 0x14
Content of register 9 -> 0x4
```

Sport – High resolution

Pressure register configuration = 0x27	Temperature register configuration = 0xA0
PM_RATE =2 → 4 measurements/second PM_PRC = 7 → oversampling 128 times	TMP_EXT = 1 TMP_RATE = 2 → 4 measurements/second TMP_PRC = 0 → No oversampling

Source code

```
xensiv_dps3xx_config_t dps368_config =
{
    .dev_mode               = XENSIV_DPS3XX_MODE_BACKGROUND_ALL,
    .pressure_rate          = XENSIV_DPS3XX_RATE_4,
    .temperature_rate       = XENSIV_DPS3XX_RATE_4,
    .pressure_oversample    = XENSIV_DPS3XX_OVERSAMPLE_128,
    .temperature_oversample = XENSIV_DPS3XX_OVERSAMPLE_1,
    .data_timeout           = 1000,
    .i2c_timeout            = 500,
};
```

Debug output

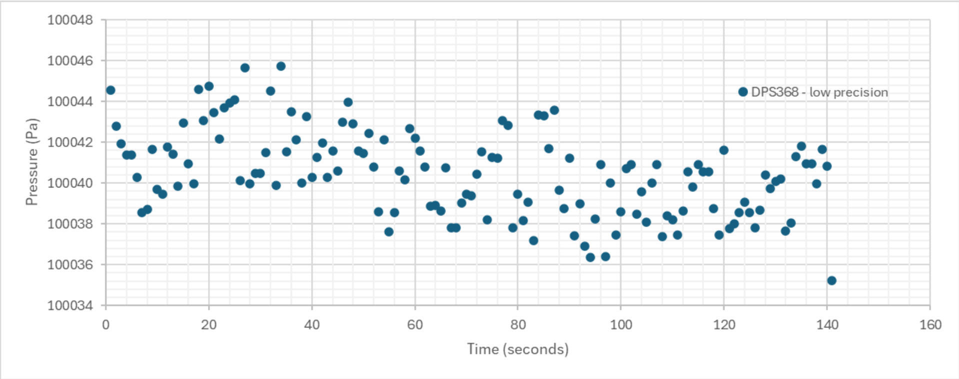
```
_xensiv_dps3xx_set_temperature_config
Content of register 7 -> 0xa0
_xensiv_dps3xx_set_pressure_config
Content of register 6 -> 0x27
Content of register 9 -> 0x4
```

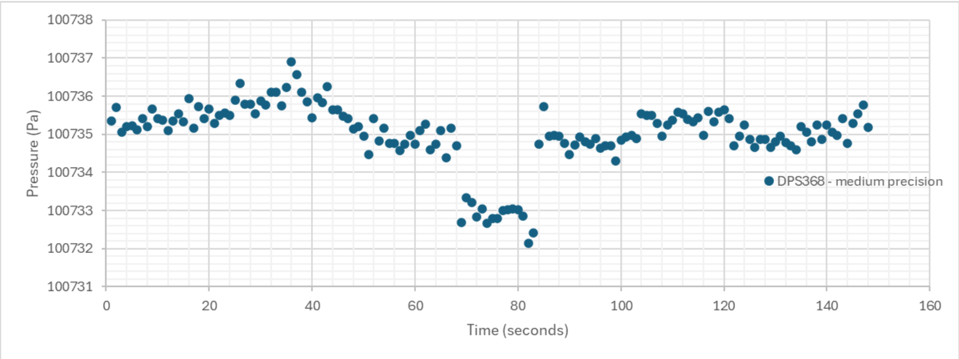
Measurements (one pressure sensor)

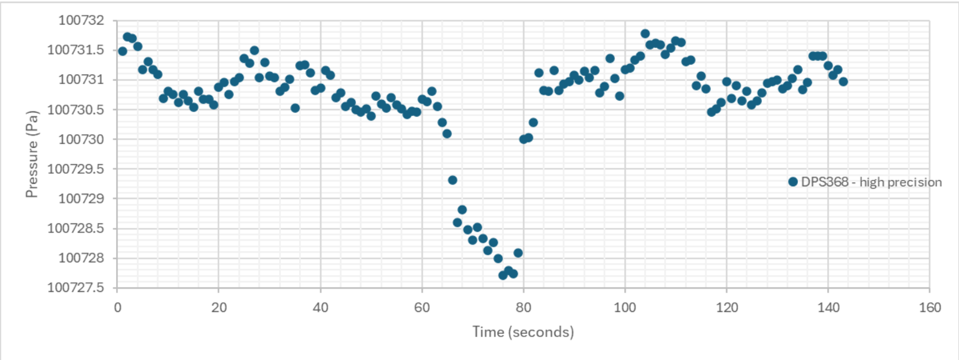
The measurement scenario:

1. The DPS368 sensor lays on a desk for 60 seconds,
2. We put it on a box of 17cm height for 10 seconds,
3. We put the sensor back on a desk for 60 seconds.

Below you can see the results in different configurations (low, medium and high precision).

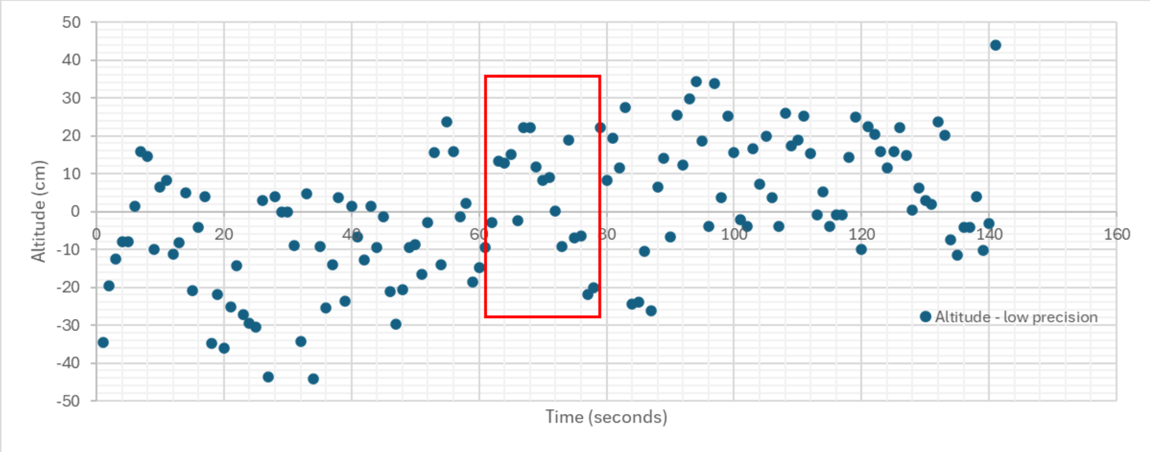


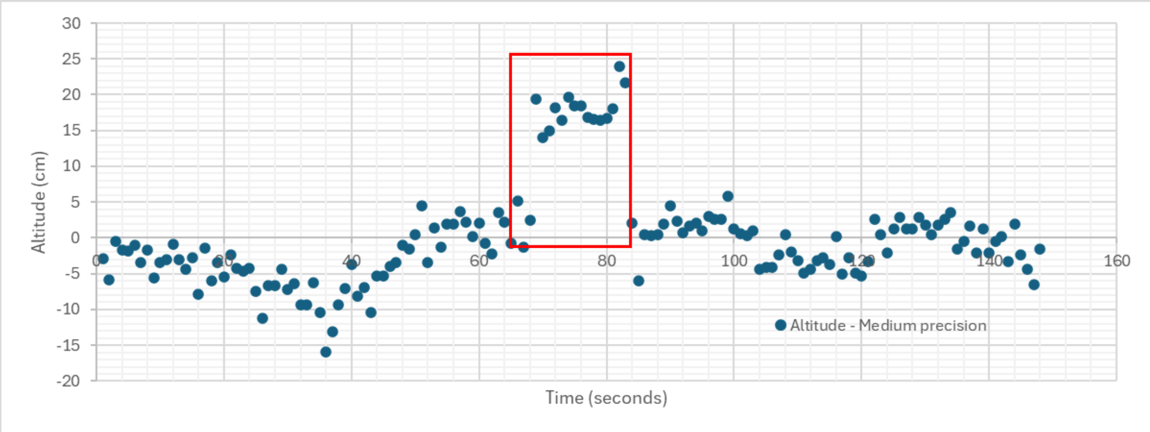


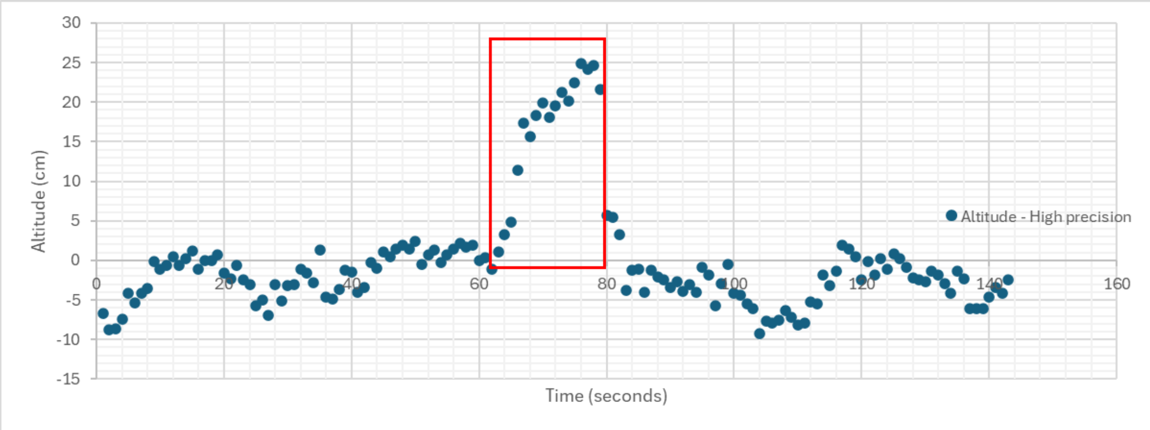


We see the “jump” at time ~60seconds corresponding to the sensor lift for both medium and high precision (cannot see it for low precision because not accurate enough).

Let´s convert the pressure to an altitude, and show the variation for low, medium and high precision (we remove the average value for all samples):







A change of 17cm in the altitude results in a change of around 2.5Pa.

Let´s calculate the standard deviation σ (for 66% of the values) for the first 60 seconds:

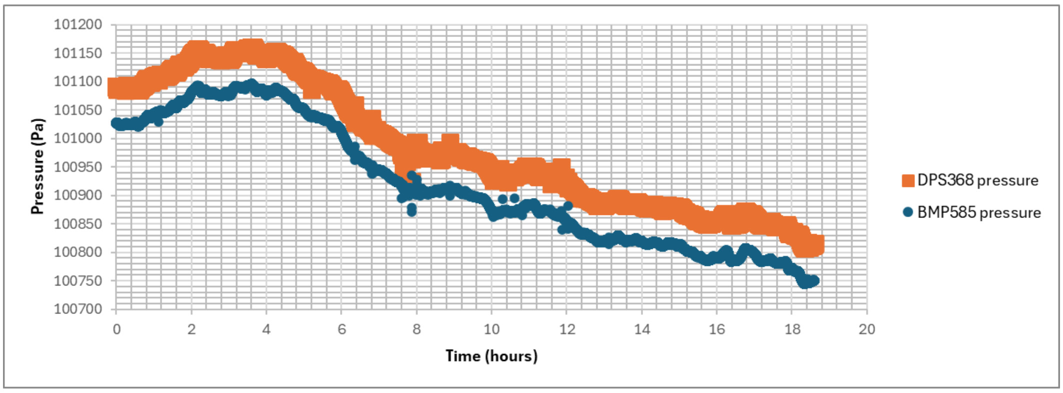
$$\sigma_{low\ precision} = 15.6cm$$

$$\sigma_{medium\ precision} = 4cm$$

$$\sigma_{high\ precision} = 2.85cm$$

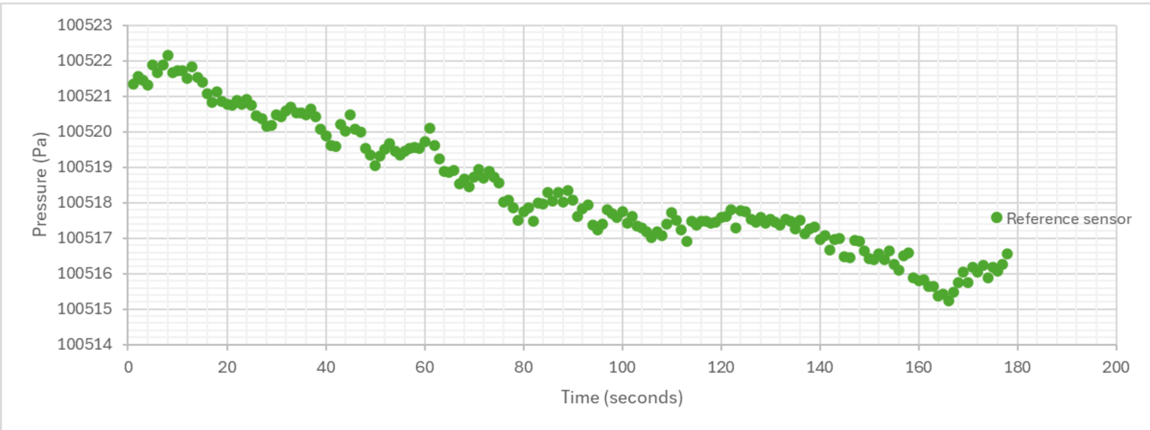
The variation during the first 60 seconds on the plots below is due to the small atmospheric pressure changes. We decided to check how the atmospheric pressure changes during the day and used two sensors for it: Infineon´s DPS 368 and Bosch´s BMP 585.

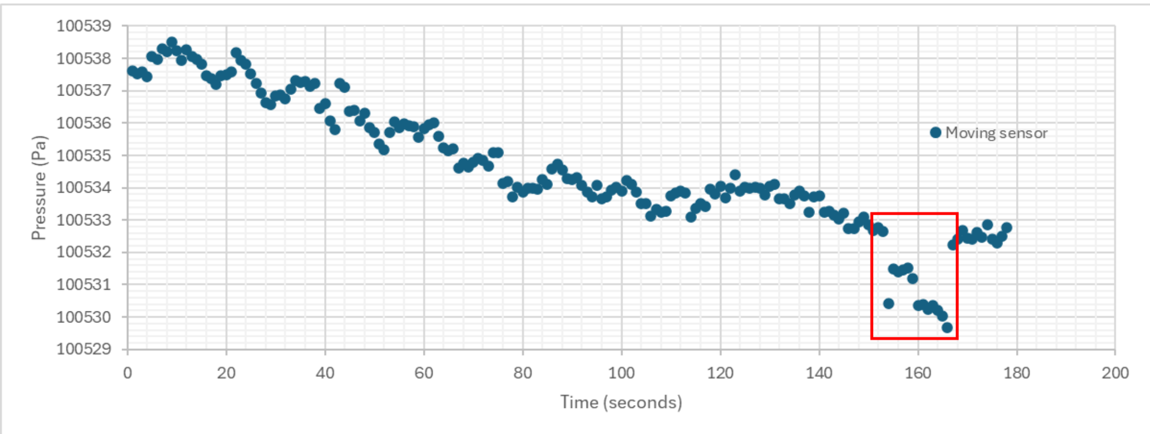
Result: the variation over 18 hours is more of about 400Pa. Comparing to the measured pressure change of 2,5 Pa, it´s a major shift of the pressure.



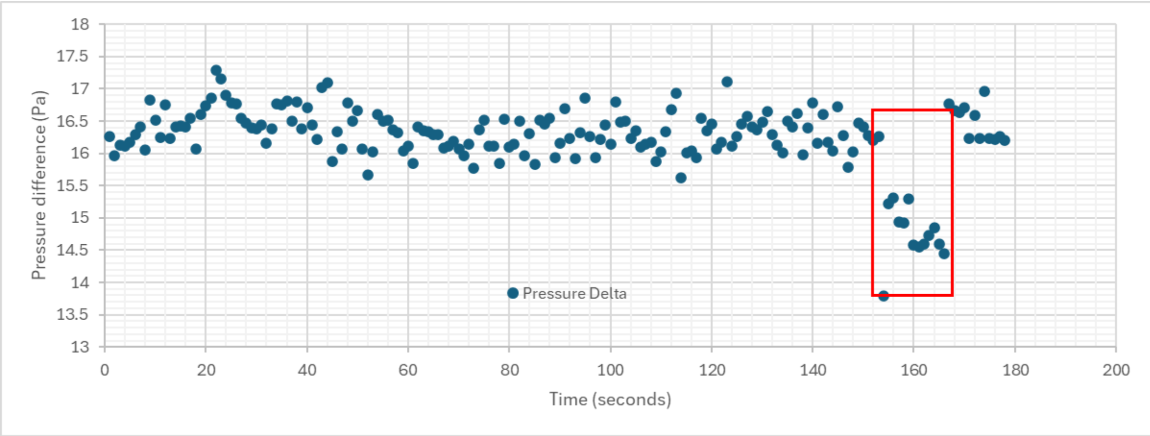
Enhance system precision (two pressure sensors)

To “counteract” the changes in the atmospheric pressure (mostly due to temperature), we can use a differential system. One DPS368 pressure sensor (a reference one) always performs at a constant altitude, and the other one is attached to the moving object. The measurements are performed in a high precision configuration.

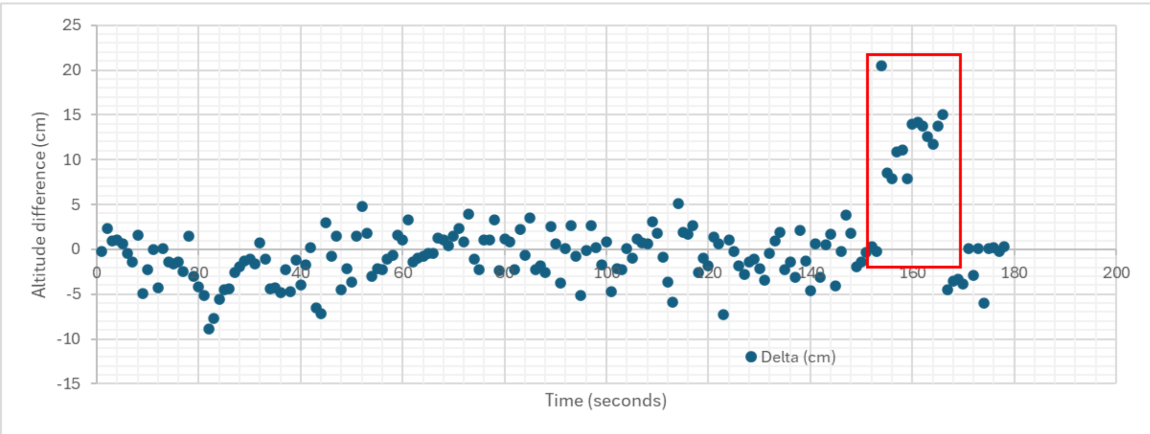




The moving sensor provides a "blue signal" that indicates that an altitude change occurred. Let´s calculate the pressure difference between the values of moving and reference sensors:



And convert this difference in Pa into a difference in cm that becomes more obvious with the differential system.



$$\sigma_{high\ precision} = 2.65cm$$

Conclusion

The change of the atmospheric pressure during the day affects the pressure measurement results. For instance, the pressure (and altitude) measurements performed in the morning time will differ from the results obtained at the same altitude, but in the evening time. To exclude the effect of the atmospheric pressure and get the optimal measurement results, we recommend using two DPS368 pressure sensors.