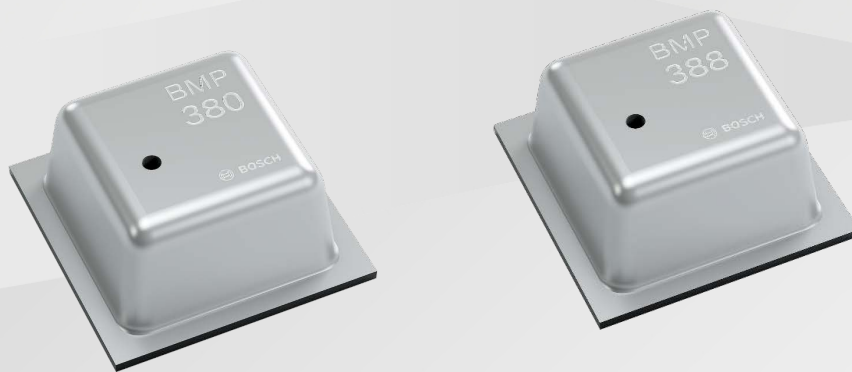


Application Note

Correction of errors induced by fast temperature changes



Application Note

Document revision	1.2
Document release date	April 2018
Document number	BST-BMP38x-AN004-00
Technical reference code(s)	

Notes

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BMP38x

Digital pressure sensor



The BMP38x is a digital sensor with pressure and temperature measurement based on proven sensing principles. The sensor module is housed in an extremely compact 10-pin metal-lid LGA package with a footprint of only $2.0 \times 2.0 \text{ mm}^2$ and max 0.8 mm package height. Its small dimensions and its low power consumption of $3.4 \mu\text{A} @ 1\text{Hz}$ allow the implementation in battery driven devices such as mobile phones, GPS modules or watches.

Typical applications

- Vertical velocity indication (e.g. rise/sink speed)
- Internet of things
- Enhancement of GPS navigation
(e.g. time-to-first-fix improvement, dead-reckoning, slope detection)
- Indoor navigation & localization (floor detection, elevator detection)
- Outdoor navigation, leisure and sports applications
- Weather forecast
- Health care applications (e.g. spirometry)
- Fitness applications like enhancement of calorie detection
- AR & VR applications
- Context awareness

Target Devices

- Flying toys
- Drones
- Handsets such as mobile phones, tablet PCs, GPS devices
- Navigation systems
- Portable health care devices
- Home weather stations
- Watches
- White goods

Key features

- Package 2.0 mm x 2.0 mm x 0.8 mm metal lid LGA
- Digital interface I²C (up to 3.4 MHz) and SPI (3 and 4 wire, up to 10 MHz)
- Supply voltage V_{DD} main supply voltage range: 1.71 V to 3.6 V
V_{DDIO} interface voltage range: 1.2 V to 3.6 V
- Relative accuracy typ. ± 8 Pa, equiv. to ± 0.66 m
(700 ... 900 hPa, 25 ... 40 °C)
- Absolute accuracy typ. ± 50 Pa
(300 ... 1100 hPa, 0 ... +65 °C)
- Temperature coefficient offset typ. ± 0.75 Pa/K
(-20 ... 65 °C @ 700 - 1100 hPa)
- Current consumption 3.4 µA at 1 Hz pressure and temperature
2.0 µA in sleep mode
- Operating range -40 – +85 °C, 300–1250 hPa
- The product is RoHS compliant, halogen-free, MSL1

BMP38x enables accurate altitude tracking and is specifically suited for drone applications. The best-in-class TCO between 0-65°C for accurate altitude measurement over a wide temperature range of the BMP38x greatly enhance the drone flying experience by making accurate steering easier. It is compatible for use with other Bosch sensors, including the new BMI088 for better performance, robustness and stability. The new BMP38x sensor offers outstanding design flexibility, providing a single package solution that can also be easily integrated into other existing and upcoming devices such as smart homes, industrial products and wearables.

The sensor is more accurate than its predecessor BMP38x, covering a wide measurement range from 300 hPa to 1250 hPa. This new barometric pressure sensor exhibits an attractive price-performance ratio coupled with low power consumption. It is available in a compact 10-in 2.0 x 2.0 x 0.75 mm³ LGA package with metal lid

Due to the built-in hardware synchronization of the pressure sensor data and its ability to synchronize data from external devices such as acceleration sensors, the BMP38x is ideally suited for fitness and navigation applications which require highly accurate, low power and low latency sensor data fusion.

The new interrupt functionality provide simple access to data and storage. Examples of interrupts than can be used in a power efficient manner without using software algorithms include: Data ready interrupt, watermark interrupt (on byte level) or FIFO full interrupt.

BMP38x also includes a new FIFO functionality. This greatly improves ease of use while helping to reduce power consumption of the overall device system during full operation. The integrated 512 byte FIFO buffer supports low power applications and prevents data loss in non-real-time systems.

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1 Correction of errors induced by fast temperature changes

By default, in the BMP38x, temperature and pressure are measured sequentially. However, in case of fast temperature changes of $>0.5^{\circ}\text{C}/\text{sec}$. this can lead to errors in temperature compensation of the sensor.

The reason is that the temperature during the temperature measurement (UT) does not match the temperature during the pressure measurement (UP) in case of fast temperature changes. A difference of 0.5°C between these two measurements leads to an error in pressure of typically 1hPa.

In most of the applications the temperature changes are so slow that this effect can be neglected. However, in applications where fast heating or cooling of the sensor can be expected, the following sequence can be used to cancel the error. It is recommended in applications of direct exposition to sunshine or when the sensor is located close to power components on the PCB.

The method to compensate the influence of fast temperature changes is introduced by applying a symmetric sequence of measuring UT and UP, e.g.

```
Step # 1: measurement of UT1
Step # 2: measurement of UP1
Step # 3: measurement of UP2
Step # 4: ...
      .
      .
      .
Step #(n-1): measurement of UP(n-2)
Step # n: measurement of UT2
```

By averaging two measurements each, the average time points for UT and UP measurements are equal (centre of sequence). A slope of temperature over time will not have an influence anymore, it will be cancelled by the symmetry.

For averaging more than 2 values of UP, we recommend one measurement of UT at the beginning and one at the end of the sequence, with $n_samples$ measurements of UP in between.

Averaging of UT can be done by $UT = (UT1 + UT2) / 2$. The sum of UP1 to $UPn_samples$ can be directly processed by the BMP38x software version 2.4, in combination with the variable $n_samples$.

Please note, that this sequence of measurement is already implemented in the Bosch Sensortec Evaluation-Board firmware from version 1.7 onward.

2 Legal disclaimer

2.1 Engineering samples

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3 Document history and modification

Rev. No	Chapter	Description of modification/changes	Date
1.0		Document creation	April 2018
1.1		Change document name	April 2018
1.2		Update	April 2018



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Modifications reserved | Printed in Germany
Preliminary - specifications subject to change without notice
Document number: BST-BMP38x-AN004-00
Revision_1.2_042018