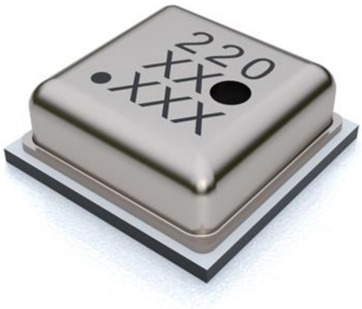
ScioSense



ENS220

Application note

Fall Detection

ENS220 application note: Fall Detection

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1 Introduction

Gravity exerts a constant and powerful force on all of us, pulling objects to the ground, sometimes resulting in unwanted fall events. Hence detecting fall events can be of great interest for both human safety and inventory monitoring. Both can be achieved with the ENS220 barometric pressure sensor, which will be explained in this application note.

Terminologically, a distinction is made between fall detection and drop detection. Fall detection technology is primarily used for the elderly and automatically identifies when a person falls and may need assistance. In contrast, drop detection, which is often used in transportation and consumer electronics, focuses on monitoring sudden drops of objects or devices. While fall detection focusses on human well-being, drop detection aims to maintain the integrity and functionality of products and goods.

In this application note, both applications are referred to as fall detection and the proposed solution is applicable in both contexts. This arises from the common characteristic that both human falls and the dropping of objects are associated with height changes - a parameter that can be easily detected by the ENS220 barometric pressure sensor (see also chapter 4). The sensor can detect changes in altitude down to the centimeter, owing to its high resolution and sensitivity to changes in air pressure caused by changes in altitude.

In contrast to accelerometers, which are excellent at measuring acceleration, the ENS220 has the advantage that it reliably measures movement perpendicular to the earth's surface, regardless of its orientation in space. In addition, the remarkable sampling rate of the ENS220, which can measure pressure up to a thousand times per second, outperforms any other barometric pressure sensor in terms of speed, noise level and energy efficiency. Such capabilities are crucial for detecting fall events occurring within milliseconds.

This document is intended to support the development at the customer side.

2 Hardware setup & requirements

The ENS220 has an I²C and SPI interface, which are both suitable for this application. Chapter 9 of the ENS220 datasheet describes in detail, how to connect a microcontroller to the sensor. There is no special requirement for case and PCB design, however, please consult the ENS220 application note about design-in recommendations.

The ENS220 is a very versatile sensor that can be customized for any application where a pressure sensor is required. In this application, the sensor is configured to have a high output data rate as the events to be measured occur within a short period of time. Table 1 contains a suggested configuration for the purpose of fall detection. Applying these settings results in an output data rate (ODR) of approximately 500 Hz. Alternatively, the conversion time can be set to 1 ms (P_CONV=0) to obtain an ODR of 1 kHz. Please read chapters 6 and 8 of the ENS220 datasheet to understand the parameters in detail.

Table 1: ENS220 configuration suggestion for fall detection. The sensor should be configured measuring pressure only (MEAS_T=0, MEAS_P=1), with a conversion time of 2 ms (P_CONV=1) in continuous mode (STBY_T=0). Leave all other registers at default values.

STBY_T	MEAS_T	MEAS_P	P_CONV
0 (0 ms, continuous)	0 (off)	1 (on)	1 (2 ms)

3 Detection method

Figure 1 illustrates the barometric pressure signal recorded with the ENS220 during a fall event. During free fall, there is a clear increase in barometric pressure, given its proportionality with altitude above sea level. Height change can be determined approximately by dividing change in the pressure signal by 12 Pa/m. 12 Pa corresponds approximately to a height change of 1 m at standard temperature (20 °C) and pressure (1000 hectopascal).

ENS220 can measure pressure signal with high resolution and speed such that the fall moment can be identified. Comparing the height after and before fall results in the height of the fall. We have further developed and tested an algorithm that identifies drops with high sensitivity and specificity. Further information can be provided on request.

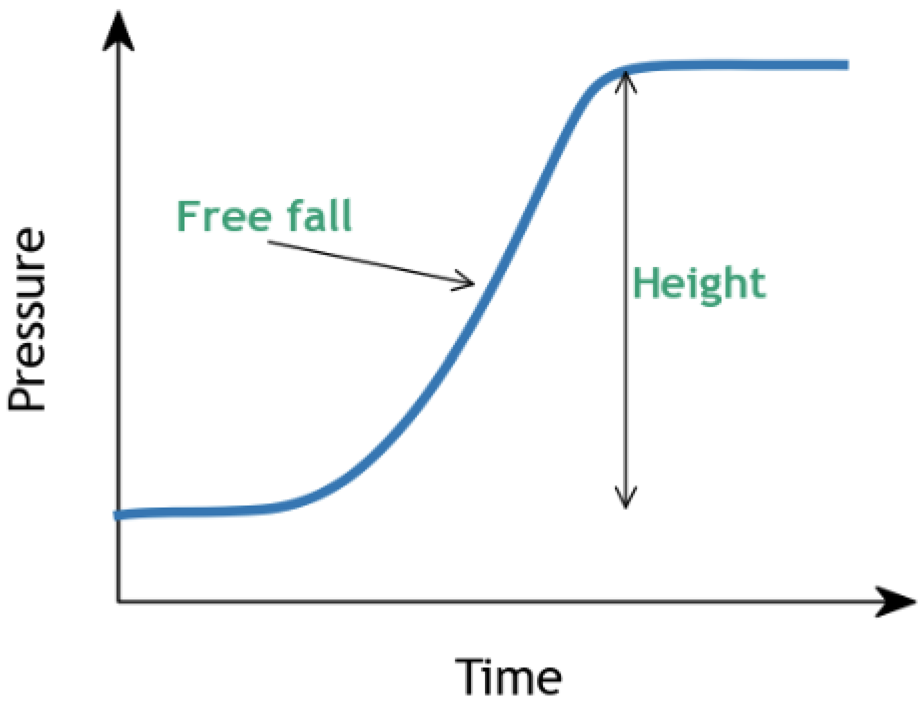

Figure 1: Drawing (not to scale) of the pressure signal in the event of a fall.

4 Advantages and limitations

Our test on a prototype shows that a fall detector using ENS220 can fully detect fall events from a height of 1 meter in a controlled indoor environment. However, the detection rate depends on the specific application and full detection cannot be guaranteed. It should be noted that false positives may occur depending on the application and environment. For critical applications a second sensor source to verify the drop event is highly recommended. In the same way, ENS220 can also serve as an excellent complementary tool for existing fall detection methods providing a reliable second opinion. Detecting drop heights of less than 1 meter is challenging. Since a drop from smaller heights becomes indistinguishable from normal handling of the device, especially given the environmental disturbances.

Compared to acceleration sensors, the ENS220 has the advantage that it reliably measures movement perpendicular to the earth's surface, regardless of its orientation in space. In addition, the ENS220 can determine the height of fall more accurately than an accelerometer, especially the longer the object or person is in free fall. It should be noted that the ambient pressure is subject to fluctuations (weather, ventilation, door openings etc.), which can influence the pressure signal and possibly falsify the height measurement.

The pressure signal used in the algorithm contains a lot more information, such as the absolute height above sea level, which can be used to determine the position inside a building or to see whether goods have been loaded onto an aircraft, for example. In addition, the ENS220 has a high-precision temperature sensor that can detect the temperature of goods or surroundings with an accuracy of ±0.1 °C.

5 Sample code

ScioSense provides more detailed information as well sample code on request. Please contact our sales representatives via our website: www.sciosense.com/support.

6 Copyrights & Disclaimer

7 Revision information

Table 2: Revision history

Revision	Date	Comment	Page
1.0	2024-04-11	First edition	All

Note(s) and/or Footnote(s):

1. Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
2. Correction of typographical errors is not explicitly mentioned.

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