

MEMO

QNH correction with SensBox

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1 Introduction

The SensBox measures the altitude using a high-precision pressure sensor. The pressure reduces with increasing altitude. But additionally the pressure is influenced by the weather. Thus to get the real altitude the measured altitude must be corrected using QNH. The QNH is the barometric pressure adjusted to sea level. The altitude is then calculated from a measured pressure using ISA atmosphere with the following formula:

$$h = \frac{T_0}{-\gamma} \left(1 - \sqrt[p_0]{\frac{p + \Delta p_0}{p_0}} \right), \text{with}$$

$$\Delta p_0 = p_0 - p_{QNH}$$

g_0	9.80665	m s ⁻²	acceleration of gravity
$Rstar$	8.31432*10 ³	Nm kmol ⁻¹ K ⁻¹	gas constant (R * M)
M_L	28.964425	kg kmol ⁻¹	mean molecular weight of dry air
T_0	288.15	K	temperature of dry air at sea level
γ	-6.50*10 ⁻³	K m ⁻¹	temperature gradient of the atmosphere
p_0	1013.25	hPa	defined sea level pressure value of the atmosphere at sea level
h		M	Geometric height
p		hPa	Current measured pressure at height
p_{QNH}		hPa	QNH setting

This calculation is performed inside the SensBox. The display on the SensBox always shows QNH corrected altitude. The output via Bluetooth Low Energy can be adjusted to be QNH-corrected altitude or QNE altitude. The QNE altitude is the altitude at standard pressure

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(QNH=1013.25). The altitude is present in two characteristics: Navigation and Movement. It is possible to individually set for these characteristic whether to return QNH or QNE altitude.

1.1 Definitions

QNH altitude	Pressure altitude corrected with QNH to get the geometric altitude.
QNE altitude	Pressure altitude calculated with standard pressure (1013.25)
External application	Any software that connects to the SensBox using BLE. The external application is usually implemented in iOS or Andorid
Settings infrastructure	The SensBox provides a communication interface which can be used to read or write SensBox settings from an external application. See BLE protocol definition for more details.

1.2 Characteristics related to barometric altitude

The characteristics are described in detail in the BLE protocol definition document. A barometric altitude is present in the Navigation characteristic and in the Movement characteristic. By default both characteristics return QNE altitude. This can be changed by sending a setting change using the settings infrastructure:

BLE_UseQNH_Nav=1

BLE_UseQNH_Mov=1

The altitude in the Movement characteristic has 1cm resolution while the resolution in the Navigation characteristic is limited to 1m.

The currently set QNH can be read in the system characteristic (10^1 Pa resolution) or using the settings infrastructure (QNH_Pa, in Pa).

The current pressure can be read in the system characteristic.

1.3 Automatic QNH adjustment using GPS altitude

The SensBox has feature to automatically adjust the QNH based on the GPS altitude. If enabled (default setting), the QNH is automatically adjusted such that the QNH altitude matches the GPS altitude if the GPS precision is sufficiently good. The adjustment is done using a low pass filter to reduce effects from GPS noise. The feature is automatically disabled when a take-off is detected or when the QNH is manually set (using QNH_Pa setting or using user interface on the SensBox).

The feature can be enabled/disabled using:

QNHAutoAdjust=[1 or 0]

Default setting is 1.



2 Procedures for BLE devices

2.1 Option 1: Let the SensBox deal with QNH correction

This option is the preferred implementation. The SensBox handles QNH correction. The external application directly reads the QNH corrected altitude from the SensBox. Any QNH entered in the external software is submitted to the SensBox using the Settings infrastructure.

By default the SensBox submits QNE altitude with its characteristics. This has to be changed by sending either of the following settings using the settings infrastructure:

BLE_UseQNH_Nav=1

BLE_UseQNH_Mov=1

These settings are not persistent thus they must be set after each BLE connect.

Any change in QNH from the external software must be transmitted using:

QNH_Pa=101325 (example for 1013.25 hPa)

Please note that setting the QNH_Pa setting disables the QNH automatic adjustment by GPS. Thus it is recommended to only update the QNH if “new evidence” is present such as user input or any other mechanism that calculates a more accurate QNH inside the external application.

Alternatively a specific current altitude can be set which triggers the SensBox to update the QNH such that the QNH altitude matches the given altitude:

BLE_QNH_from_m=500 (example for 500m)

Please note that this setting is write-only.

2.2 Option 2: Calculate QNH correction in external application, but synchronize QNH with SensBox

If the external application decides to do the QNH correction inside its software, it is still strongly recommended to synchronize the QNH of the external application with the QNH of the SensBox. First, the SensBox also displays QNH corrected altitude and it confuses the user if the altitude on the SensBox doesn't match the altitude in the external application. Second, the SensBox allows for automatic QNH adjustment based on GPS altitude which is a well-accepted feature. By synchronizing the QNH with the external application those features will continue to work.

The external application should use the QNH given in the System characteristic for its QNH correction. Any update to the QNH from the external application should be submitted using the QNH_Pa setting.

Please note that setting the QNH_Pa setting disables the QNH automatic adjustment by GPS. Thus it is recommended to only update the QNH if “new evidence” is present such as user input or any other mechanism that calculates a more accurate QNH inside the external application.



Alternatively a specific current altitude can be set which triggers the SensBox to update the QNH such that the QNH altitude matches the given altitude:

BLE_QNH_from_m=500 (example for 500m)

Please note that this setting is write-only.