



Beat-to-Beat Intervals (BBI) Product Description

What are Beat-to-Beat Intervals (BBI)?

Beat-to-beat intervals (BBI) is the time between two successive heart beats as measured using a photoplethysmography (PPG) sensor. This is equivalent to the time between the peaks of the R peaks of the QRS complex on an electrocardiogram (ECG). BBI is measured in milliseconds (ms). The LifeQ BBI solution uses PPG data which is obtained from an optical sensor using green light emitting diodes (LEDs). This technology is typically found in most wrist-worn wearables today that provide HR. BBI is measured as the time elapsed between the peaks of each consecutive heart beat.

BBI varies throughout the day and a key derivative of BBI is Heart Rate Variability (HRV), which is used to describe and interpret these variations. BBI is governed by both the sympathetic “fight-or-flight” and the parasympathetic “rest-and-digest” branches of the autonomic nervous system and accurate measurement of BBI and HRV enables the calculation of a range of health metrics and insights that are key in tracking amongst other things sleep, heart health, recovery and stress.

The LifeQ solution combines:

- **Real time sensor management software** that optimises the quality of the PPG signal. This includes accounting for things like skin colour, temperature, blood perfusion, device fit, as well as motion, all of which can impact the signal quality and therefore ultimately the HR accuracy. The LifeQ solution does this while at the same time striving for the lowest possible power consumption to make the battery last as long as possible
- **Signal confidence tracking** that constantly tracks the quality of the signal and determines whether it is of sufficient quality to extract accurate BBI.
- **A BBI algorithm** that adjusts to conditions to ensure the best combination of accuracy and power consumption at any given time.

What BBI Outputs are provided by LifeQ?

In order to calculate HRV, very high levels of accuracy are required from a PPG device. For this reason, LifeQ currently only provides BBI during periods of no motion. While the LifeQ solution continuously samples the device data, it only outputs BBI when the signal is judged ‘good enough’ during these no motion scenarios, thereby ensuring accurate inputs are available for further calculations.

Outputs from the LifeQ BBI solution include:

- **Beat-to-Beat Intervals (BBI)s** measured in milliseconds provided continuously (for each heartbeat interval) during no motion periods.
- **Heart Rate Variability (HRV)** - There is a wide range of approaches that can be utilized to perform HRV analysis of the LifeQ BBI output. LifeQ can assist customer with guidance and project specific collaboration.

Accuracy

LifeQ conducts comprehensive testing of the LifeQ BBI solution using a specific BBI Protocol and in addition as lifestyle protocols across a broad cohort of test subjects and devices in order to ensure a realistic view of the expected performance. A summary of these results is provided below with a detailed description of the results available in the [LifeQ Beat-to-Beat Interval \(BBI\) Product Validation Document](#).

LifeQ BBI Protocol Statistics

Table 1: The average error for all participants (including a range of demographics and skin colours)

Device	Mean Absolute Error (ms)	Standard deviation (ms)	Coverage % (when BBI is available)
All Devices - LQ BBI Protocol	20.97	40.51	35%
All Devices - 24 hours	17.17	42.35	46%
All Devices - Sleep only	10.64	26.87	89%

Coverage - Shows the amount of time that a “good enough” signal was available, which is governed by environmental conditions most importantly motion (if a person is moving the signal is excluded) and to a lesser extent temperature, device fit and participant perfusion).

Table 2: The distribution of error on a sample of of no less than 20 random participants (including a range of demographics and skin colours) during the LifeQ BBI protocol

Device	Mean Absolute Error (ms)	Standard deviation (ms)	Coverage % (when BBI is available)
Best Performing Device	12.50	33.00	36.00%
Worst Performing Device	35.00	55.00	41.00%