boley
UHREN- UND SCHMUCKTECHNIK

accuracy²

swiss made

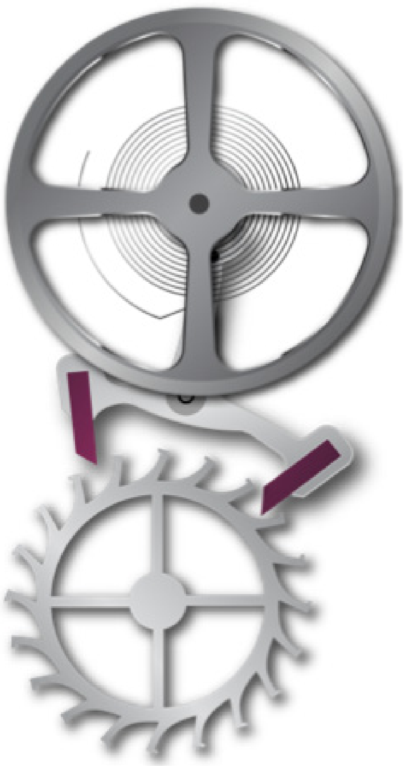
USER MANUAL

Art.-No. 695 227

How does a mechanical watch work?

From the energy stored in the mainspring of the barrel to the oscillating system regulating the time, the video on youtube https://youtu.be/3MUL65-vZHY perfectly explains in simple terms how a mechanical watch basically works.

Watch in detail how the time is regulated by the combined action of the escapement and the oscillating system, the “heart of the watch”, composed of the balance wheel and the hairspring.



Acting just like a brake, the Swiss lever escapement transmits the energy from the mainspring to the balance wheel.
Attached to the hairspring – a tiny spring in spiral shape – is the balance wheel that beats, or oscillates, extremely accurately at a frequency between 2.5 and 5 times per second*.

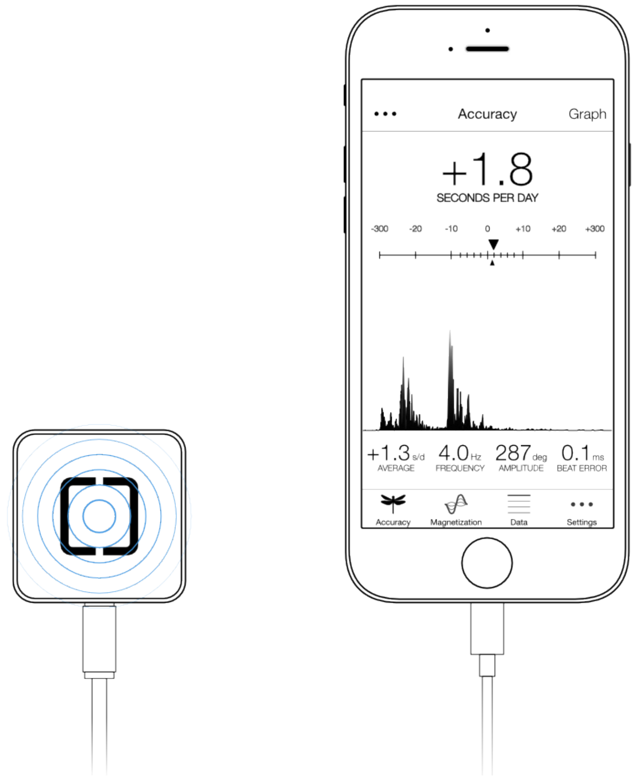
Aging, gravity, vibrations, temperature, magnetization, etc., all of these factors can interfere with the regulator organ causing the balance wheel to oscillate slightly faster or slower, which in turn makes the watch run faster or slower. This deviation, called the rate accuracy, is expressed in seconds per day [s/d].

**The range of beating frequencies mentioned above, expressed in Hertz [Hz], is found in the vast majority of watches.*

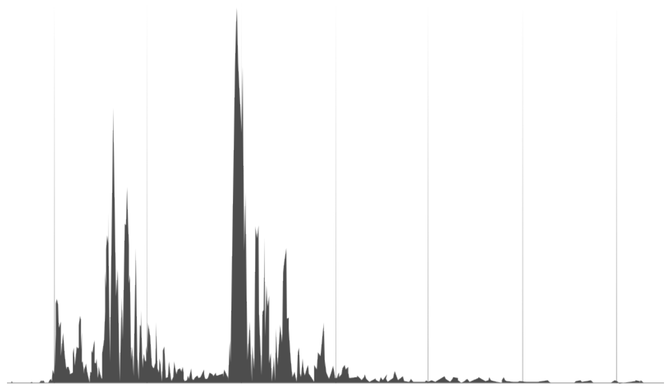
How do ONEOF sensors work?

The energy is being transmitted from the escapement to the balance wheel mainly by parts that are pushed or slides by each other making the well known “ticking” or “tick-tock” sound.

ONEOF products are made up of an ultra sensitive sensor which is capable of detecting every single vibration caused by the ticking sound. Each of these small vibrations is converted into an audio signal, highly amplified, digitalized and transmitted to the device where every second, complex algorithms process tens of thousands of data.



The ticking sound of the Swiss lever escapement consists of 3 different pulses, displayed on the main page of the ONEOF App.
The first pulse is temporally very precise and therefore it is used for the computation of the rate deviation and the beat error.
A second pulse is very irregular and cannot be used.
The third and most powerful pulse is used to estimate the amplitude of the balance wheel.



Rate accuracy

The rate accuracy is an instantaneous indication of the deviation of the balance wheel beating frequency and is expressed in seconds per day [s/d].

A watch can run faster or lower and its accuracy changes over time as a result of a wide variety of perturbations: internal imperfections in the gear train, aging of the oils, gravity and vibrations, temperature variations, magnetization of the hairspring, etc.

A watch is “accurate” when its daily variation is within the range determined by the brand. For example:

• Rolex: -2…+2 s/d
• Omega, Master Chronometer certification: 0…+5 s/d
• COSC certified movement: -4…+6 s/d
• Or any other ranges: -10…+10 s/d, -15…15 s/d, etc.

Frequency

The frequency is the number of oscillations the balance wheel does over time.
ONEOF app expresses the frequency in Hertz [Hz] which is the number of oscillations per second.
Watchmakers also commonly uses the number of beats, or vibrations, per hour.
The common frequency range automatically detected by the ONEOF App is:

2.5 Hz ▶ 18’000 b/h
2.75 Hz ▶ 19’800 b/h
3.0 Hz ▶ 21’600 b/h
3.5 Hz ▶ 25’200 b/h
4.0 Hz ▶ 28’800 b/h
5.0 Hz ▶ 36’000 b/h

Beat error

The beat error is the time difference between the “ticks” and the “tocks” and is expressed in milliseconds [ms].
It indicates an asymmetry in the balance wheel’s vibrations. The beat error should remain between 0.0 and 0.8ms.
Above, it can reduce the amplitude, degrade the accuracy and increase the time needed for a watch movement to start.

Amplitude

The amplitude of a balance wheel, expressed in degrees [deg], is the angle formed from its equilibrium state up to the maximum rotation.
When the movement is fully winded, the amplitude values are generally located between 260° and 310°, depending on the gravity, the frequency, the aging of the oils, etc.

The computation of the amplitude **always remains an estimation and the result must be used carefully**. Indeed, in order to calculate the amplitude, the time between the first and the third pulse of the beat noise is measured. Between these two pulses, the balance wheel rotates a certain angle: the lift angle which is determined by the construction of the movement (see below).

Lift angle

The lift angle is the angle in degrees [deg] covered by the balance wheel between the first and the third peak of the escapement signal.

It is a geometric feature, determined by construction and given by the manufacturer.
In the watchmaking industry, the lift angle is known to be inaccurate: between 2 movements of the same production,
a variation of +/- 3° of the lift angle is not rare. As a 1° change equates to about 7° change of the amplitude value, that is the reason why the acoustic measurement of the amplitude remains an estimation (manufacturers always use more precise laser measurement).

For the most of the standard watch movements the lift angle is about 51°.

Integration time

Due to phenomenons related to the acoustic physics, the rate accuracy must be averaged over a period called the integration time, expressed in seconds [s].

The different integration time values are: 2s, 10s, 20s, 30s or 60s.
The lower the time integration, the less stable the measurement. However, a low integration time allows the measurement to show more detailed fluctuations.

Basically, you would use a long integration time (30 or 60s) for inaccurate vintage watches or if you use the ONEOF Accuracy2 in a noisy environnement.
If the watch is stable, accurate, and you are doing the measurement in a calm environnement, you can use a lower integration time.

The integration time can be changed in the App settings in expert mode only, before or during a measurement.

Measuring a watch with ONEOF Accuracy²

If the watch is equipped with a screw-down system, unlock the crown.

Fully wind the watch by turning the crown clockwise.

Place the watch on the sensor.

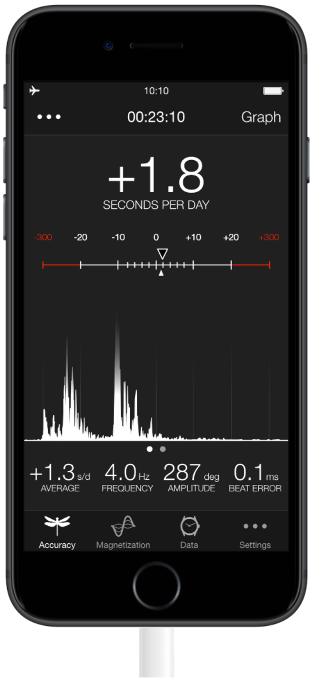
The crown should be placed in the center of the ONEOF logo.

The App detects the presence of the watch and starts its initializing process.

The frequency is automatically computed after a few seconds only.

The accuracy of the watch is displayed at the top of the screen after
2 to 60s, depending on the time integration chosen in the settings.

The measurement will continue unless the watch is removed from the sensor.

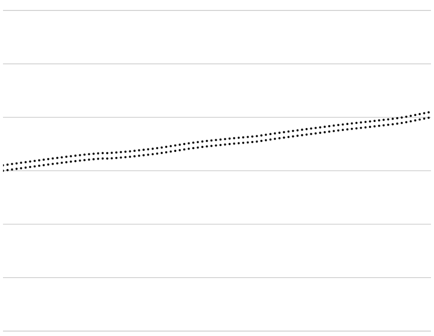


The vibrograph chart display.

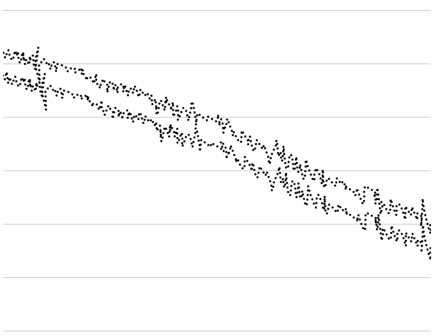
Swipe right to display the “Vibrograf” chart, historically used by watchmakers where each dot represents a tick or a tock over time and formed of two lines.

If the watch tends to run faster, the slopes are positive.
If the watch tends to run slower, the slopes are negative.
If the watch is perfectly accurate, the chart displays flat lines.

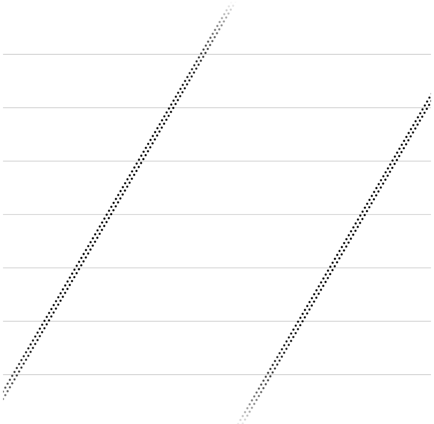
In case the watch has no beat error, the two lines are superimposed. If the beat error is greater than 0.0ms, the lines are spaced. The bigger the beat error, the larger the space between the lines.



Stable & accurate watch running slightly faster with low beat error.

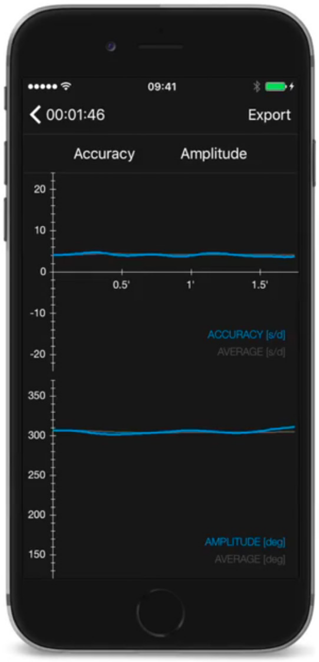


Inaccurate vintage watch or noisy environnement.
Increase the integration time for an improved rate stability result.



Watch gaining hundreds of seconds per day.
Might be magnetized.

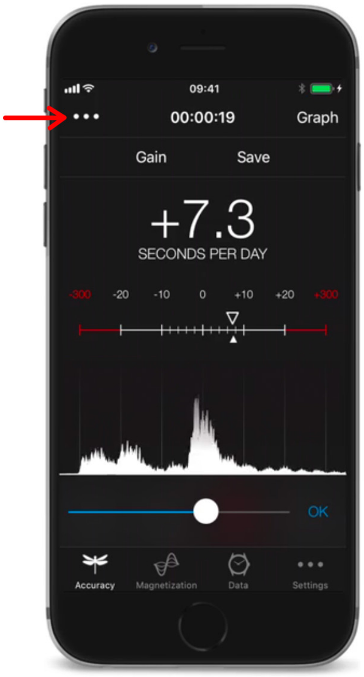
Track the results with the cumulative charts.



It is often interesting to check how both the accuracy and the amplitude vary over time.

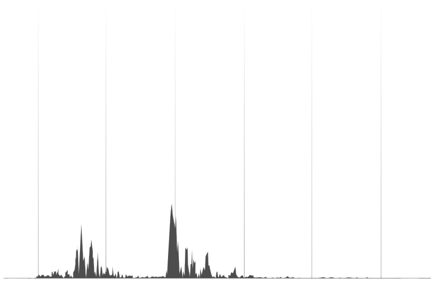
Some particular and natural fluctuations might appear, like the impact of defects in the gear train, the drop of the amplitude during the change date, or more generally the variation of the rate accuracy over the entire power reserve of the watch.

Adjusting the sensor sensitivity / gain.

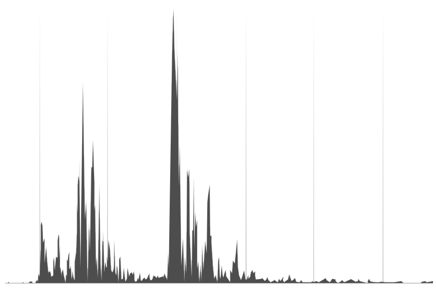


In rare cases, the sensor input gain, or sensitivity, needs to be adjusted in order to improve the measurement stability. It usually happens with very noisy movements, mainly 2.5Hz vintage ones, or when the measurement is done in a noisy environment.

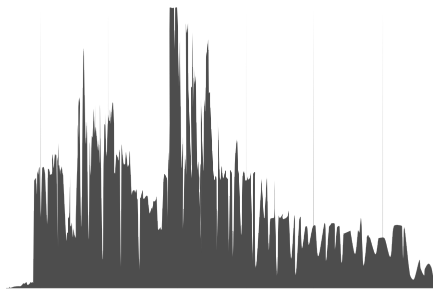
Touch the 3 dots button located on the top navigation bar, then touch the Gain button. A slider appears below the signal escapement. Adjust the gain accordingly in order to obtain the 3 peaks.



The gain is too low.
The rate accuracy may fluctuate and the amplitude may not be computed.
Try increasing the gain or change the watch position (crown, back, case…).

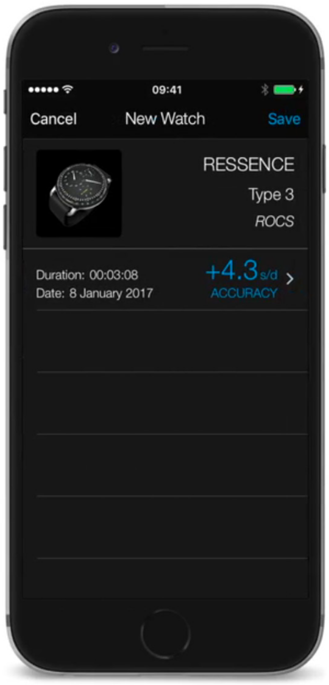


The gain is good.
The first and third pulses are sharp enough.



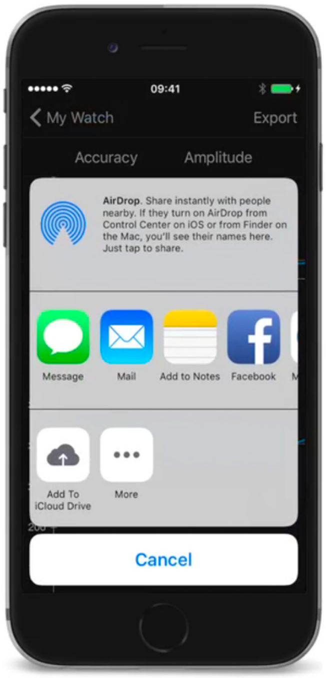
The gain is too high.
The rate accuracy may fluctuate and the amplitude may display abnormally high values (> 350°).
Try decreasing the gain or change the watch position (crown, back, case…).

Save and export the data.



You can save all of your results during the measurement in a smart integrated database. Rate accuracy, amplitude, beat error, graphs… Everything you need to track is saved.

With iOS, all your measurements are also automatically saved on iCloud to keep the data available on all your devices.



All the measurement results can be exported in a CSV file format.

You can share your results, save them in the brand new File app available on iOS 11 or process them for a detailed post-treatment with Excel.

ONEOF

General Distributor Germany:

Gebr. Boley GmbH & Co.KG
Julius-Hölder-Str. 32
D- 70597 Stuttgart

Fon +49 (0)711- 132 71-0
Fax +49 (0)711- 132 71-90
E-Mail info@boley.de
www.boley.de