
## Watch Knowledge

# Testing Times

### So your watch has a chronometer certificate. QP looks into what exactly that means

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The COSC certificate shows that a watch has been tested by the Contrôl Officiel Suisse des Chronometres and passed. COSC is a Swiss government agency, and is independent of any watch companies. In 2002, 1,229,666 certificates were issued for mechanical chronometers. The majority were for watches from Rolex (814,720), Omega (165,543) and Breitling (131,815). Officine Panerai, TAG Heuer, Baume & Mercier and Bvlgari each received more than 10,000 certificates, while a number of other well-known brands including Chopard, Zenith, Ulysse Nardin and Vacheron Constantin each got more than 1,000.

In the "free-sprung" Giromax balance by Patek Philippe, C-shaped weights placed around the balance wheel are used to adjust the rate. As indicated on the balance cock, turning the slot to face inwards (increasing the moment of inertia of the wheel) will cause the watch to go slower. Note that equal adjustments must be made to weights on opposite sides of the wheel to avoid altering the poise.

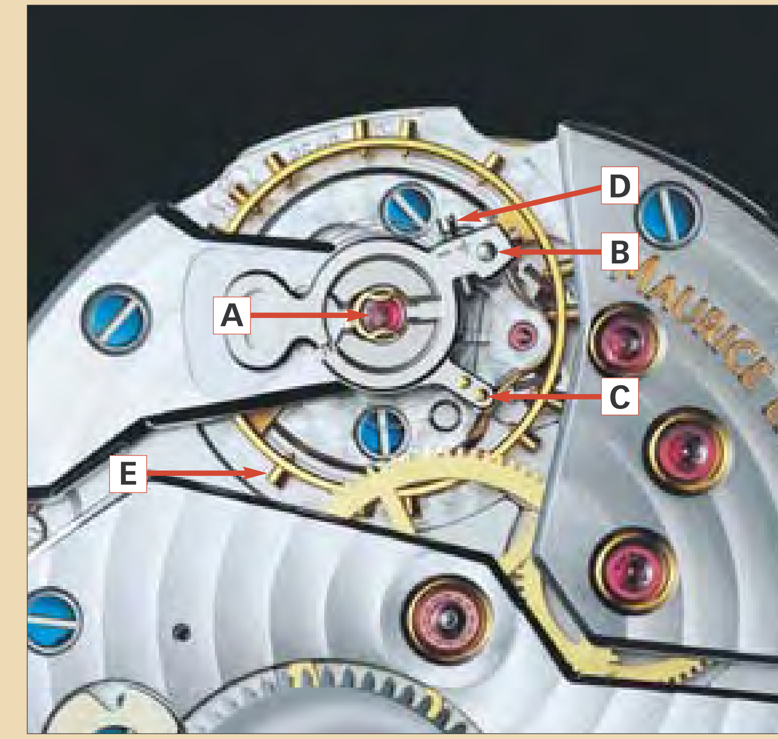
The COSC certificate looks impressively complicated but simply reports on the performance of the watch's movement when oriented in five different positions at room temperature (23°C), with additional checks in one position at 8°C and 38°C. To understand the significance of these tests we must first recall some horological basics and then look more closely at the behaviour of the balance wheel in a watch. The going train of a mechanical clock or watch has two functions. It delivers power to an oscillator (the pendulum or balance wheel) to keep it oscillating, and "counts" those oscillations to record the passage of time. A pendulum is a relatively good oscillator and, provided power is supplied to it at a constant rate, a well-made mechanical clock can keep accurate time to within 1 or 2 seconds a month. On the other hand, a mechanical watch, with its balance wheel oscillator, would be doing very well to achieve the same kind of performance.

The reason for this is that while a pendulum simply swings back and forth under the steady and reliable influence of gravity, the behaviour of a watch balance is much more complicated and presents a number of problems. Perhaps the most severe is that the balance wheel swings on an axle known as the balance staff. The balance staff is supported by four of the jewels found in the watch: two have holes and act as bearings for the balance staff, while the other two "end stones" cover the bearings at each end of the staff. When the watch is "flat" – for example, when it is placed on a table (or when the wearer is using a computer keyboard) – the balance staff is standing on end, supported on one of the end stones, and can spin freely. In this position, the balance will swing at its maximum amplitude. However, when the watch is on edge, the balance staff is horizontal and its pivots rub in the jewel holes, which means there is more friction and the swing of the balance is reduced. Hence, it is very difficult to make a balance wheel assembly in which changing the watch's position does not affect the frequency of the balance (isochronism).

## On edge

As well as testing the watch in the two flat positions – "dial up" and "dial down" – the COSC procedure checks the watch in three different edge positions: "6H", which means on edge with 6 o'clock uppermost (the H is for *haute*, which means "up" in French), "3H" and "9H". To understand why the edge positions differ, we have to look more closely at the balance spring.






The simple balance spring is a flat spiral, and does for the balance what gravity does for the pendulum. The inner end is fixed to a small disc (collet) on the balance staff, and the outer end is attached to a stud on the balance cock or the watch plate. As the balance rotates in one direction it tightens the coils of the spring, and when it swings back the other way the coils loosen up. Because one end of the spring moves with the balance and the other end is fixed, the centre of gravity of the spring will move as the spiral opens and closes. It is desirable for any rapidly rotating wheel to be balanced or poised. To achieve this, the centre of gravity must correspond with the centre of rotation at all times. Clearly, if the centre of gravity moves during rotation, poise cannot be achieved.

As the popularity of the pocket watch and wristwatch developed from the mid-19th to the mid-20th century, an enormous amount of effort went not only into developing special metals for balances and balance springs but also into the shaping of balance springs so that they opened and closed as concentrically as possible. The fixed outer end was particularly important. By 1800, Breguet had produced his "overcoil" in which, instead of being fixed off to one side, the outer end of the spring was raised up and twisted back over the spiral before being fixed to the watch plate. Although satisfactory, this is rarely done in wristwatches as it increases the thickness of the movement. In 1861, Philips experimented with flat "terminal curves" that worked just as well. However, despite these technical advances, perfection can only be approached, and has never been achieved. The COSC tests that look at timing variations in the edge positions show just how close to flawlessness the "springer" – the specialist watchmaker who sets up the balance spring – has got. Note that only three edge positions are checked – 12H is not tested. This loophole means that the skilled springer can minimise the 3H, 6H and 9H errors by dumping them in 12H, a position only achieved for those brief moments when you raise your arm to look at the time.

After going to all this trouble to get the spring set up correctly, its behaviour will change if the regulator arm is used to alter the rate of the watch. This alters the effective length of the spring and changes the way in which its centre of gravity behaves. This is why particularly fine watches – classically by Patek Philippe and Rolex, and now Omega (with the Co-Axial Escapement) and

Part of a Maurice Lacroix movement, showing the balance assembly. The end of the balance staff can be seen through the end stone (A). Note that the outer end of the balance spring is attached to the balance cock by the stud (B), and passes between two pins on an extension of the regulator arm (C) before beginning to spiral in towards the balance staff to which its other end is attached. Watches of this type are regulated by moving these pins along the spring to alter its effective length, which is the portion between the pins and the centre of the spiral. In this watch the adjustment can be done very precisely by nudging the regulator with the lateral screw (D). The poise of the balance can be adjusted using the screws on the rim of the balance wheel (E).


Along with Rolex and Omega, Breitling submit more than 100,000 watches per year to the COSC for certification.

Audemars Piguet – have what are known as "free-sprung" balances. These are regulated by altering the moment of inertia of the balance by adjusting special weights on its rim and leaving the carefully shaped balance spring untouched.

## The real world

The COSC test is carried out on very large numbers of movements, often up to several hundred thousand. They are fitted with temporary dials and a seconds hand and placed on racks where they can be oriented as required and photographed at a precise time each day so that the performance of each one can be compared with standard time. The movements are then returned to the watch companies, where they may be stored for some time and will often be dismantled, cleaned and reassembled before being cased and sold.

Because the COSC certificate relates to what the moment did on a particular week sometime in the past, the tests have little relevance to the performance of a watch on the wrist. No wearer is likely to spend equal times each day with his watch in the five positions. Watch adjusters make assumptions about the amount of time a watch will spend in each position and assume that it is worn on the outside of the left wrist.

## Turning up the heat

The COSC factor that remains to be discussed is the test at low and high temperatures. Temperature mainly affects the elasticity of the balance spring and the effectiveness of the oil; a higher temperature could increase the diameter of the balance and therefore its moment of inertia. In older watches this was certainly a problem, but modern technology has largely overcome these problems. It would be fair to say, however, that if people cared about precision timekeeping they would not buy mechanical watches. There may be some interest in seeing how far you can go with an old technology, but it does not appear that a great deal of effort has gone into improving the timekeeping of mechanical watches in the last 50 years. Indeed, performance records set in the first part of the last century have so far not been surpassed.

If you want your watch to perform as well as possible, wear it for several weeks and making a regular note of its performance. Pass this information to your watch repairer and they can then adjust the watch for your lifestyle – but do not expect it to do better than a couple of seconds a day. Our most famous contemporary watchmaker, Dr George Daniels, likes to say: "To turn a good watch into a perfect watch, just remove the seconds hand." ○