measurement matters

Testing times

Stopwatches and timers are used in a wide variety of laboratory and industrial measurements such as flow measurement, process timing, and chemical and radiological exposure control.

Modern quartz-crystal clocks and watches typically have an accuracy of better than half a second per day (six parts per million), which is well in excess of that required for many laboratory measurements. To ensure reliable measurements, it is essential that the accuracy and functionality of the clocks is proven and checked regularly, particularly where the application affects health and safety or impacts significantly on productivity.

Since 1989 the Measurement Standards Laboratory in Lower Hutt has been operating a talking clock, which provides a voice connection to the New Zealand atomic time standard. This facility provides the means to do very simple and low-cost calibrations of stop watches.

The calibration simply requires two calls to the talking clock. On the first call, the stopwatch is started at the beginning of the third "pip" while noting the time of day given by the clock. At some later time, a second call is made and the stopwatch is stopped on the third "pip" and the new time of day noted.

The relative time error in the stopwatch can be determined by dividing the difference in the time intervals from the stopwatch and the talking clock, by the time interval indicated by the talking clock.

The trickiest part of any handheld time measurement is coordinating the starting and stopping of the time of the actual event. This applies not only to the checking of the stopwatch but also to the use of the stopwatch in the field. The accuracy achieved by the measurement depends heavily upon the nature of the measurement.

When timing a purely random event, so it is not possible to predict the actual event in advance, the error may be as large as a quarter of a second.

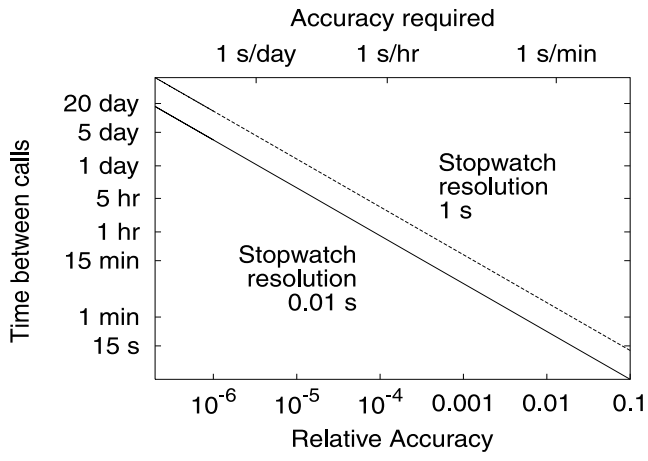
When the event is more predictable, such as when making the call to the talking clock or manually controlling the start and stop times for a machine, the accuracy of the time measurement is a little better. Experience shows that the check with the talking clock can be done with a precision of around a 10th of a second.

It is important in all these measurements to avoid anticipating the starting or stopping time. It is interesting to note that when athletic events moved from hand timing to electronic timing, the electronic times were longer than the hand measured times, because of the tendency of the person doing the timing to anticipate the finish of the race.

Once the likely error in the measurement and the resolution of the stopwatch is known, it is possible to calculate the required interval between the calls to the talking clock to achieve the accuracy required from the calibration.

The graph in Figure 1 can be used to estimate the required interval. Depending on the accuracy required, the interval between calls is normally between 15 minutes and a few days. Further details of the procedure are given in a technical guide available on the Measurement Standards Laboratory website.

The talking clock is at 0900 45678 (calls cost 99c)



Graph showing the time required between calls to the talking clock versus the required uncertainty in the calibration.

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