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Analogue quartz clocks — Timing accuracy

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Foreword

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The committee responsible for this document is ISO/TC 114, *Horology*, Subcommittee SC 14, *Table and wall clocks.*

Introduction

Each year, there is a large number of analogue quartz clocks produced and this International Standard aims to provide quality information for consumers and producers. This International Standard will help producers by giving them quality control methods and customers by informing them about expectations they could have on those products.

INTERNATIONAL STANDARD ISO 19235:2015(E)

Analogue quartz clocks — Timing accuracy

1 Scope

This International Standard specifies the basic parameters, requirements, and testing methods of timing accuracy for analogue quartz clocks, hereinafter referred to as "the quartz clock".

This International Standard applies to analogue quartz table and wall clocks which the oscillator frequency is 32 768 Hz and the nominal voltage is DC 1,5 V. Analogue quartz clock movements can refer to it.

This International Standard does not apply to the following quartz clocks:

— clocks for particular applications such as clocks used in aircraft, ship, vehicle, and facilities;

— clocks incorporated into other products;

— clocks in which time is radio-synchronized.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
mean instantaneous rate
$\overline{m}$
arithmetic mean value of three instantaneous rates of the quartz clock separately measured on three successive days, in "s/d" or "s/m"

2.2
voltage coefficient
C_U
variation rate of instantaneous rate of the quartz clock caused by the variation of source voltage

2.3
temperature coefficient
C_t
variation rate of instantaneous rate of the quartz clock caused by the variation of temperature

2.4
nominal voltage
U_n
voltage for which the movement is destined

3 Basic parameters and requirements of timing accuracy

3.1 Mean instantaneous rate, $\overline{m}$

After the quartz clock has been continuously running for 3 d, the mean instantaneous rate shall be within –1,0 s/d to +1,0 s/d.

3.2 Voltage coefficient, C_U

The voltage coefficient, C_U, shall be within –1,0 s/(d·V) to +1,0 s/(d·V).

3.3 Temperature coefficient, C_t

The temperature coefficient, C_{t1}, shall be within 0 s/(d·°C) to +0,1 s/(d·°C) and C_{t2} shall be within −0,1 s/(d·°C) to 0 s/(d·°C).

4 Test methods

4.1 Test conditions

4.1.1 Test environment

The test ambient temperature shall be 18 °C to 25 °C, the temperature variation shall be within ±2 °C during the whole test and the relative humidity shall be between 50 % and 70 %.

4.1.2 Power supply

Unless otherwise specified, the test power supply during the test shall be the nominal voltage of the quartz clock of DC 1,5 V.

4.1.3 Pre-running

Before the test, the quartz clock shall run for at least 2 h in the test environment specified in 4.1.1.

4.2 Test apparatus

The resolution and maximum permissible error of the test apparatus can refer to Table 1.

Table 1 — Test apparatus

Test apparatus	Resolution	Maximum permissible error
Instantaneous rate test instrument	0,01 s/d	±0,03 s/d
Temperature and humidity cabinet	1 °C, RH 1 %	±1 °C, RH ± 5 %
Constant voltage power supply	0,01 V	±0,5 %

4.3 Testing

4.3.1 Mean instantaneous rate, $\overline{m}$

The quartz clock shall be placed at a temperature of (23 ± 1) °C for at least 2 h. Then the instantaneous rates m_1, m_2, m_3 for the first, second and third day shall be measured respectively and the mean instantaneous rate $\overline{m}$ calculated in accordance with Formula (1):

$$\overline{m} = \frac{m_1 + m_2 + m_3}{3} \tag{1}$$

where

$\overline{m}$ is the mean instantaneous rate for 3 d;

m_1 is the instantaneous rate of the first day;

m_2 is the instantaneous rate of the second day;

m_3 is the instantaneous rate of the third day.

4.3.2 Voltage coefficient, C_U

The instantaneous rate variation of the quartz clock caused by 1 V voltage variation is called the voltage coefficient, C_U, when the supply voltage of the quartz clock is reduced from 100 % U_n to 90 % U_n.

The instantaneous rates of the quartz clock $m_{1,50}$ and $m_{1,35}$ shall be measured respectively under the supply voltage of DC 1,50 V and DC 1,35 V, when U_n is 1,50 V, and C_U is calculated in accordance with Formula (2):

$$C_U = \frac{m_{1,50} - m_{1,35}}{1,50 - 1,35} \tag{2}$$

where

C_U is the voltage coefficient, in s/(d·V);

$m_{1,50}$ is the instantaneous rate under the voltage of DC 1,50 V (100 %), in s/d;

$m_{1,35}$ is the instantaneous rate under the voltage of DC 1,35 V (90 % U_n), in s/d.

4.3.3 Temperature coefficient, C_t

The variation of instantaneous rate caused by 1 °C temperature variation is called temperature coefficient, C_{t1}, when the temperature is decreased from 23 °C to 8 °C. The variation of instantaneous rate caused by 1 °C temperature variation is called temperature coefficient, C_{t2}, when the temperature is increased from 23 °C to 38 °C.

The quartz clock shall be placed at a temperature of 23 °C ± 1 °C for at least 2 h, then the instantaneous rate, m_{23}, shall be measured. Afterwards, it shall be placed at a temperature of 8 °C ± 1 °C for at least 2 h, then the instantaneous rate, m_8, shall be measured. After the test, it shall be placed for 1 h in the environment described in 4.1.1 and then placed at a temperature of 38 °C ± 1 °C for at least 2 h. Afterwards, the instantaneous rate, m_{38}, shall be measured. C_{t1} and C_{t2} are calculated in accordance with Formula (3) and Formula (4), respectively:

$$C_{t1} = \frac{m_{23} - m_8}{23 - 8} \tag{3}$$

where

C_{t1} is the temperature coefficient when the temperature is decreased from 23 °C to 8 °C, in s/(d·°C);

m_{23} is the instantaneous rate at 23 °C, in s/d;

m_8 is the instantaneous rate at 8 °C, in s/d.

$$C_{t2} = \frac{m_{38} - m_{23}}{38 - 23} \tag{4}$$

where

C_{t2} is the temperature coefficient when the temperature is increased from 23 °C to 38 °C, in s/(d·°C);

m_{23} is the instantaneous rate at 23 °C, in s/d;

m_{38} is the instantaneous rate at 38 °C, in s/d.

Annex A
(informative)

Main factors affecting the timing accuracy

A.1 General

The main factors affecting the timing accuracy of the quartz clocks are temperature and ageing.

A.2 Temperature

The quartz crystal frequency and the load capacitance value inside the oscillation circuit of the quartz clock change along with the temperature. This change will have impact on the timing accuracy of the quartz clock. The timing accuracy of the quartz clock at the low or high temperature is different from the timing accuracy at the test environment temperature of (23 ± 1) °C. The instantaneous rate shall be within –2,0 s/d to +1,0 s/d in the temperature range of 8 °C to 38 °C.

A.3 Ageing

The main ageing factors for quartz clock include the following:

— ageing of the quartz;

— ageing of the load capacitance inside the oscillation circuit;

— decrease of the vacuum encapsulation of quartz.

The ageing factors will have certain impacts on timing accuracy of the quartz clock. Usually, after the quartz clock has been used in normal condition (10 °C to 35 °C, RH ≤ 70 %) for 1 y, it may cause ±0,2 s/d variation in mean instantaneous rate. Consumers should be aware of this ageing impact on timing accuracy after the quartz clock has been regularly used over 1 y.

Annex B
(informative)

Timing accuracy expressions of quartz clocks

B.1 General

Expressions of timing accuracy of the quartz clock differ in different countries or regions. Thre are three expressions as follows:

— instantaneous daily rate;

— instantaneous monthly rate;

— average monthly rate.

B.2 Instantaneous daily rate

Test the timing accuracy of the quartz clock within a short time and convert it into a daily rate called instantaneous daily rate, in s/d.

B.3 Instantaneous monthly rate

Test the timing accuracy of the quartz clock within a short time and convert it into a monthly rate called instantaneous monthly rate, in s/m.

B.4 Relationship between instantaneous daily rate and instantaneous monthly rate

Instantaneous monthly rate = Instantaneous daily rate × 30

NOTE The monthly rate assumes there are 30 days in a month.

B.5 Average monthly rate

The value that was calculated monthly rate from the cumulative total of probable rate of 1 y. Method of simulation of probable rate is different by each of the countries and regions.

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