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Methods of evaluation of the battery life of a battery-powered watch

Méthodes d'évaluation de l'autonomie de fonctionnement d'une montre à pile

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 12819 was prepared by Technical Committee ISO/TC 114, *Horology*.

Annexes A and B form a normative part of this International Standard.

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Methods of evaluation of the battery life of a battery-powered watch

1 Scope

This International Standard specifies two methods for determining the battery life of a battery-powered watch and specifies the labelling to be used by the manufacturers or the distributors to inform the users.

According to the available information, either the theoretical battery life or the practical battery life is calculated using the formulae given in this International Standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 6426-2, *Horological vocabulary — Part 2: Technico-commercial definitions.*

IEC 60086-3, *Primary batteries — Part 3: Watch batteries.*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 6426-2 and the following apply.

3.1
battery life
operating duration of a battery-powered watch, as determined by the characteristics of the battery and the movement

NOTE The battery life starts when the battery is inserted into the watch and lasts until the point when the voltage falls below the level required for operation and the watch stops.

4 General

4.1 Parameters

The following parameters affect the calculation:

— the type of battery used;

— the type of movement used;

— the operating and environmental conditions.

4.2 Battery life

This International Standard considers two types of battery life for battery-powered watches:

— practical battery life, which takes into consideration the self-discharge of current during storage and operation;

— theoretical battery life, which assumes a perfect battery with no self-discharge of current.

4.3 Operating mode

The operating mode may be normal or economic. Some watches are equipped with an interruptable supply to the motor which allows the power consumption to be reduced to the required value to operate the oscillator.

NOTE This device is used mainly during storage periods of the watch. The operating mode should be indicated in the user instructions.

4.4 Environmental conditions

The values determined are valid for normal environmental conditions as follows:

— a temperature of 28 °C ± 2 °C;

— a relative humidity of (50 ± 10) %.

5 Current consumption of a watch

5.1 Mean current consumed by the movement (I_m)

The mean current (I_m) is the average of currents consumed for the display of time of day function(s) excluding all additional functions. The mean current is expressed in microamperes.

For a movement with a mechanical display, the consumption shall be measured on a large number of pulses of the motor.

For a movement with a digital display, the consumption shall be measured when a mean number of digits are operating.

5.2 Capacity of the battery (C)

The capacity of the battery used to determine the battery life of a watch shall conform to the value specified by the manufacturer of batteries and controlled by the watchmaker, in accordance with IEC 60086-3. The capacity (C) is expressed in milliamperes per hour.

5.3 Self-discharge currents (I_{as}, I_{ad})

5.3.1 Self-discharge current in storage (I_{as})

When a battery is stored it sustains an annual loss which affects capacity. Retention of capacity depends on the type of battery and the storage temperature and humidity. It is equivalent to the mean self-discharge current in storage (I_{as}), expressed in microamperes according to the formula:

$$I_{as} = \frac{\Delta C_s}{8{,}76}$$

NOTE The 8,76 value is the ratio between the number of hours in the year (8 760) and the conversion rate from milliamperes to microamperes (1 000).

The value ΔC_s is usually supplied by the manufacturer. In the case of lack of information from the manufacturer, the values given in annex A shall be used. ΔC_s is expressed in milliamperes per hour.

5.3.2 Self-discharge current in use (I_{ad})

When the same battery discharges, the average self-discharge current (I_{ad}), expressed in microamperes, may be different. It is determined by the formula:

$$I_{ad} = K \times I_{as}$$

NOTE The value K depends on the type and size of the battery as well as the operating conditions (e.g. temperature).

The value K is usually supplied by the manufacturer. In the case of lack of information from the manufacturer, the values given in annex A shall be used.

5.4 Current consumption of additional functions (I_f)

The mean current (I_f) consumed over a day by an additional function is calculated by the following formula:

$$I_f = \frac{i_f \times t}{86\,400}$$

where

I_f is the mean current expressed in microamperes (µA);

i_f is the consumption of the function expressed in microamperes (µA);

t is the time of use, in seconds, during one day of the function.

The usual values of t for additional functions used for the determination of I_f are those, expressed in seconds, that are mentioned in the user instructions for each product. In the absence of these values, in most cases the values given in Table A.1 in annex A are conventionally selected.

NOTE The values are approximate and may change over a wide range from one user to another. They are of interest only for comparison between products.

6 Calculation of battery life

6.1 Practical battery life (AP)

The practical battery life (AP), expressed in years, is determined by the following formula:

$$\text{AP} = \frac{C - (n \times \Delta C_s)}{\left(I_m + I_{ad} + \sum I_f\right) \times 8,76}$$

where n is the storage duration, expressed in years, of the battery from its manufacture until the time it is put into the watch.

For comparison between products, the watch manufacturer shall use under his own responsibility the values $n = 1$ or $n = 0,5$.

For the battery life indication, the watch manufacturer shall take into consideration the intrinsic battery life, of which indicative values are given in annex B.

6.2 Theoretical battery life (AT)

The theoretical battery life (AT), expressed in years, is determined by the following formula:

$$AT = \frac{C}{\left(I_m + \sum I_f\right) \times 8{,}76}$$

7 Labelling

The indication of the practical or the theoretical battery life of a watch shall be expressed in years and, if necessary, this value shall be rounded to the half year immediately below the calculated value. However, if this value is below 2 years, it shall be expressed in months.

The following wording shall be used:

> "The practical (or theoretical) battery life of this watch determined in accordance with the method specified in ISO 12819, with a (trademark of the battery) battery, reference ....., is ... years (or months)."

Annex A
(normative)

Self-discharge currents

A.1 General

The following numerical values for calculating factors ΔC_S and K (see 5.3) shall be used when information is not supplied by the battery manufacturer.

A.2 Values for ΔC_S

$\Delta C_S = 0{,}05 \times C$ for silver oxide batteries;

$\Delta C_S = 0{,}02 \times C$ for lithium batteries;

where

C is the nominal capacity of the battery;

the factors 0,05 and 0,02 express the yearly capacity retention agreed according to the type of battery.

A.3 Values for K

$K = 1$ for an unworn watch or one that is stored at a temperature $\leqslant$ 23 °C;

$K = 2$ for a worn watch, i.e. one that is subjected to temperatures between 28 °C and 30 °C.

A.4 Conventional values for use for complementary functions

Table A.1 — Conventional values for use

Functions	**Daily use** t (in seconds)
A) Display lighting	20
B) Alarm strike	20
C) Hour strike	12
D) Timer strike	20
E) Function strike	12
F) Chronograph	3600
G) Calculator	1800
H) Electronic hand-setting (alarm or time-zone)	20

Annex B
(normative)

Practical battery life (AP)

B.1 Intrinsic lifetime of a battery

Battery technology is constantly being developed. The current reference values are as follows:

a) silver oxide batteries:

— of height $\leqslant$ 2,15 mm: 3 years;

— of height $>$ 2,15 mm: 4 years.

b) lithium batteries: 5 years to 10 years.

NOTE The use of the higher battery life values is made on the responsibility of the watchmakers.

B.2 Alternative method for determining practical battery life (AP)

The practical battery life AP, expressed in years, can also be determined using the following formula:

$$AP = \frac{1}{\beta} \ln \left[\frac{\beta (C - 0{,}5 \Delta C_s)}{8{,}76 \times \left(I_m + \sum I_f \right)} + 1 \right]$$

$$\beta = -\frac{\ln (1 - \alpha)}{n'}$$

where

n' is the time, in years;

β is the proportional factor of self-discharge;

α is the average rate of self-discharge over n' years.