BS ISO 1413:2016

BSI Standards Publication

Horology — Shock-resistant wrist watches

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National foreword

This British Standard is the UK implementation of ISO 1413:2016.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 114, *Horology*, Subcommittee SC 1, *Shock resistant watches*.

This third edition cancels and replaces the second edition (ISO 1413:1984), which has been technically revised with the following changes:

a) added a third shock on the watch head (on the crown);

b) added two free-fall shocks, including the bracelet.

Introduction

This International Standard is intended to allow the homologation test of watches rather than the individual control of all watches of a production batch. Indeed, assuming that each watch could comply with the minimum requirements without apparent damage, readjustment could still be made necessary because the test can lead to an alteration of the initial functions and rate of a complete watch.

Horology — Shock-resistant wrist watches

1 Scope

This International Standard specifies the minimum requirements for shock-resistant wrist watches and describes the corresponding test method.

It is based on the simulation of the shock received by a wrist watch while falling from a height of 1 m onto a horizontal wooden floor (an equivalent surface is described in B.1.1).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3158, *Timekeeping instruments — Symbolization of control positions*

ISO 22810, *Horology — Water-resistant watches*

3 Terms and definitions

For the purpose of this document, the following definitions apply.

3.1
shock-resistance
ability to sustain impacts without damage

3.2
shock-resistant watch
watch that resists mechanical shocks according to this International Standard's requirements

3.3
display components
elements of the watch which determine and display a physical value to the consumer

EXAMPLE Hands, calendar disks, rotating cylinders, pointers or any other mechanical devices.

Note 1 to entry: This includes any electro-optical display elements of the watch which determine or display, through their position, contrast, polarity, colour, sound or other properties, a physical value to the consumer.

3.4
residual effect
occurrence of failures or changes in the watch functions as a result of exposure to shocks

Note 1 to entry: Any kind of failures are considered as residual effects. In order to determine the degree of shock resistance, residual effects are divided into *permanent residual effect* (3.5) and *reversible residual effects* (3.6).

3.5
permanent residual effect
changes in the display information and in the watch functions which remain present after the test

Note 1 to entry: The consumer does not have the ability to remedy said failures or reset the functions without the intervention of a professional watch service. These failures may include the following:

— disconnected or repressed gear train of the hour and/or minute mechanism;

— sliding of the hour hand on the hour wheel axis or the minute hand on the cannon pinion axis;

— switched off LCD or electronic display segments, buzzers etc.;

— broken or cracked components;

— de-synchronization between hour and minute display.

3.6
reversible residual effect
changes in the display information and in the watch functions which are temporarily present after the test

Note 1 to entry: The consumer has the ability, without professional assistance, to reset or readjust the changes onto initial values or conditions. Displacements can be reset manually to the initial position or initial value by the consumer using the time or calendar setting mechanism.

Note 2 to entry: Although adjustable failures are classified as less critical, certain limits of adjustable failures of the display or of the watch function shall be considered.

EXAMPLE Displaced minute hand due to a sliding cannon pinion and displaced calendar disk due to a sliding jumper spring.

4 Test conditions

4.1 Test temperature

Throughout the test period, the ambient temperature shall be between 18 °C and 25 °C.

4.2 Water resistance

Watches labelled water-resistant shall comply with ISO 22810.

For watches being tested and labelled in compliance with ISO 22810, the water resistance must remain intact after the shock exposures on watch heads. See 5.2.

4.3 Shock characteristics

The test apparatus for the three first shocks (shock test apparatus) and the test apparatus for the free-fall shocks shall comply with shock characteristics described in Annex A.

If the test apparatus for the free-fall shock cannot be checked according to Annex A, its impact surface shall be identical to the impact surface of the sabot.

4.4 Test apparatus

4.4.1 Material

Sabot (shock test apparatus) and impact plate (free-fall test apparatus) shall be made with the same material (see B.1.1).

4.4.2 Shock test apparatus

An example of test apparatus for the shocks is described in Annex B and shall comply with its specifications.

4.4.3 Free-fall test apparatus

The free fall shall be from a height of 1 m.

An example of test apparatus for the free-fall shocks is described in Annex C.

4.5 Preliminary settings of the test samples

4.5.1 Determination of the rate for mechanical watches

The rate of the watch under test shall be checked 30 min to 60 min after winding to maximum, respecting a stabilization time ≥ 30 s prior to any rate measurement. The rate measurement duration shall be ≥ 40 s in each of the positions FH, 6H and 9H in accordance with ISO 3158, using an apparatus capable of measuring the instantaneous rate.

4.5.2 Determination of the rate for quartz watches

Quartz watches shall function for at least 2 h before starting the test; after this period, the rate shall be checked in position CH or FH using an apparatus for measuring the instantaneous rate.

4.5.3 Determination of the watch head setups

— Mechanism for the drive of calendar or other watch display items shall be set in a non-engaged, non-armed position.

— Chronograph display items shall be set in the reset (zero) position.

— LCD segments or any other electronic display item shall be checked and should all be functional.

— The time setting and (if applicable) the calendar setting function shall work correctly, without gear disengagement or abnormal rotating friction.

— The stop function of the watch movement (if applicable) shall work correctly.

— All functions of push buttons or sliding switches, e.g. Start – Stop – Reset of chronographs; On – Off function for buzzer, lighting or any other function present, shall work correctly.

— Functional elements providing any mechanical, vibrating, acoustic, or any other signals shall be functional.

— Screw-down crowns or push buttons (if applicable) shall be set to the screwed-down position, as in normal use. Other crowns shall be set in the normal use position.

5 Test method

5.1 General

Watches to be tested shall be separated for two different procedures.

— Shock test procedure applies to functional watch heads only and shall be used for shocks 1, 2 and 3.

NOTE Shock 3 can be applied on a different watch head than that used for shock 1 and 2.

— Free-fall test procedure applies to complete watches with bracelets (including movement or equivalent dummy) and shall be used for free-fall shocks 1 and 2.

Flowcharts summarizing the following procedures (5.2 and 5.3) are described in Annex D.

5.2 Procedure for shocks on watch heads

5.2.1 General

The watch heads shall be tested without having a bracelet or a strap attached.

The watch heads are exposed to shocks applied with an apparatus complying with Annex B or equivalent.

Watches labelled water-resistant shall comply with ISO 22810, where water resistance must remain intact after the shock exposures on watch heads.

NOTE Water-resistance can be checked after each shock.

5.2.2 First shock

5.2.2.1 Watch setups and shock description

The time shall be set at 12:00 am position, ±2 min.

Possible time setting positions before first shock are given in Figure 1.

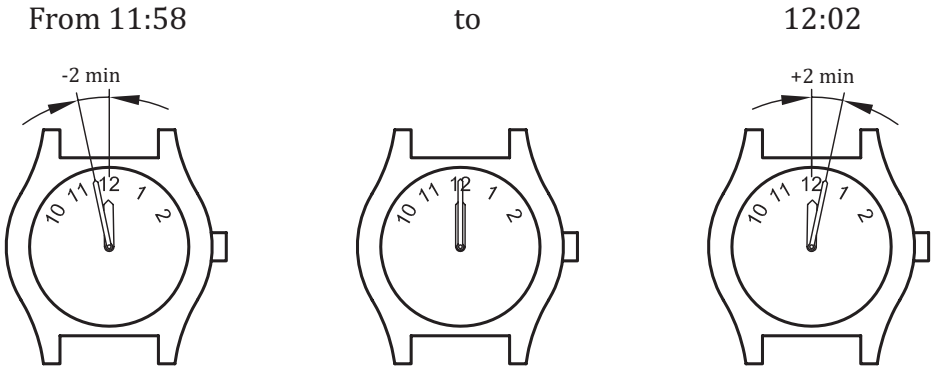


Figure 1 — First shock initial time setting positions

The shock shall be directed against the middle part of the watch case, parallel to the plane of the watch head, on the "9 o'clock" side. See Figure 2.

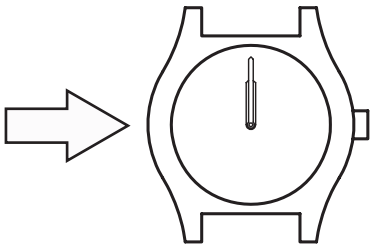


Figure 2 — First shock direction

Similarly, in the case of watches with a digital display, the shock shall be applied at the same location.

5.2.2.2 Requirements after the first shock

The displacement of the minute hand shall be observed in reference to the initial time setting position (see Figure 3):

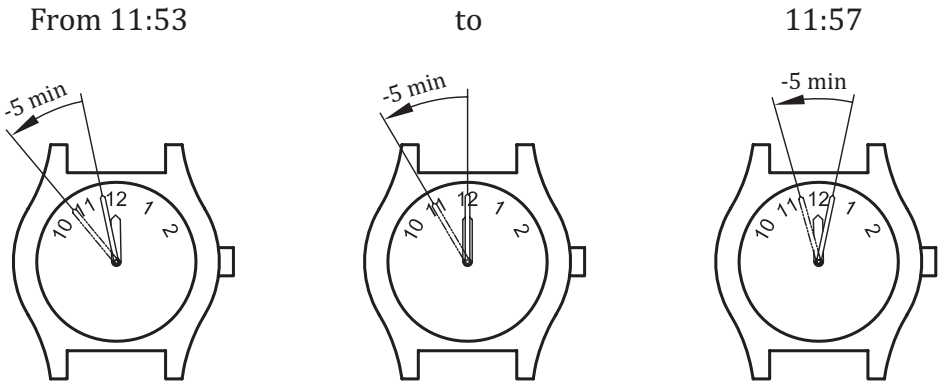


Figure 3 — Maximum admissible displacement of minute and hour hands

On LCD or electronic displays, there is no displacement tolerance, all segments shall remain functional.

5.2.3 Second shock

5.2.3.1 Watch setups and shock description

No specific setup is required.

The shock shall be directed against the glass, perpendicular to the plane of the watch head. See Figure 4.

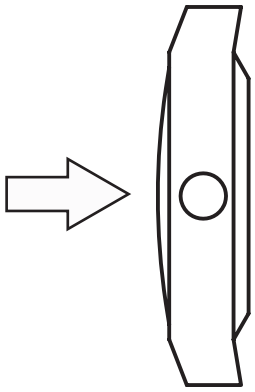


Figure 4 — Second shock direction

5.2.3.2 Requirements after second shock

5.2.3.2.1 Quartz watches

Allowing a recovering period ≥ 5 min after the second shock, the rate of the watch shall be checked in position CH or FH using an apparatus capable of measuring the instantaneous rate.

5.2.3.2.2 Mechanical watches

Allowing a recovery period ≥ 5 min after the second shock and after a stabilization time ≥ 30 s prior to any rate measurement, the rate of the watch shall be measured.

The rate measurement duration shall be ≥ 40 s in each of the positions FH, 6H and 9H using an apparatus capable of measuring the instantaneous rate.

The residual effect on the rate shall be calculated from the greatest difference of rates determined in the same position.

For practical reasons, the above measurements can be done with a time delay ≥ 60 min after winding to the maximum.

5.2.3.2.3 Permanent residual effects

— Changes of the rate shall not exceed: 2 s per day for quartz watches or 60 s per day for mechanical watches.

— Permanent changes of the time (hour and minute) are not accepted.

— Permanent changes on day and/or date are not accepted.

— Changes of electronic display items causing mistakable or non-determined time reading are not accepted.

— The examination of the watch shall not reveal any permanent deterioration affecting its functions, its performance or its appearance (e.g. hands bent or fallen off, altered display, impaired automatic device or calendar, rotating bezel, cracked glass, bent horns, bent or broken crown or damaged push-button, etc.).

5.2.3.2.4 Reversible residual effects

— Reversible changes of the time displayed after the shocks shall not exceed −5 min/−30°, respectively for the angular displacement of the minute hand, as shown at 5.2.2.2.

— Changes of the chronograph, alarm, countdown and any other time displayed after the shocks are accepted.

— Reversible changes of the date displayed (including day and date hands) after the shocks are accepted.

5.2.3.2.5 Water resistance

Watches labelled water-resistant and not used for the third shock shall comply with ISO 22810.

5.2.4 Third shock

5.2.4.1 General

This test exposes the crown and the winding stem to one controlled shock.

The acceptance criteria shall be related to functionality of stem, e.g. resting positions, time setting, date adjustment, initialization, movement stop and synchronization, manual winding, electrical contacts and water-resistance.

5.2.4.2 Watch setups and shock description

— The time setting and (if applicable) the calendar setting function shall work correctly, without gear disengagement or abnormal rotating friction.

— The stop function of the watch movement (if applicable) shall work correctly.

— All functions of push buttons or sliding switches, e.g. Start – Stop – Reset of chronographs, On – Off function for buzzer, lighting or any other function present, shall work correctly.

— Screw-down crowns or push buttons (if applicable) shall be set to the screwed-down position, as in normal use. Other crowns shall be set in the normal use position.

— The shock shall be directed against the crown, parallel to the axis of the time setting stem. See Figure 5.

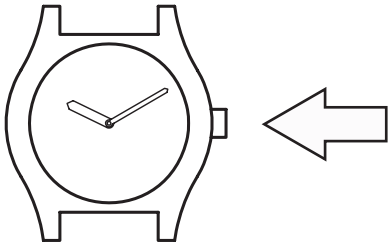


Figure 5 — Third shock direction

5.2.4.3 Requirements after the third shock

— The examination of the watch shall not reveal bent or broken crowns, push buttons or sliding switches etc. damaged by the third shock applied.

— The time and calendar settings shall remain functional.

— Watches labelled water-resistant shall comply with ISO 22810.

5.3 Procedure for free-fall test (complete watch)

5.3.1 General

It is allowed to apply the free-fall shocks on watch heads which have already been exposed to the three first shocks.

The watches are exposed to shocks applied with an apparatus complying with Annex C or equivalent.

The complete watch (band or strap fixed on the watch head including a movement or an equivalent dummy) is exposed to free falls. This is to simulate shocks resulting from free falls, occurring when the complete watch falls onto a wooden floor. The mechanical resistance of the bracelet and the linkage parts (spring bars and pins) as well as the bracelet fixation to the watch head shall be observed and judged after the tests.

5.3.2 First free fall

The complete watch shall be placed in a position with the crown up and with the clasp open. See Figure 6.

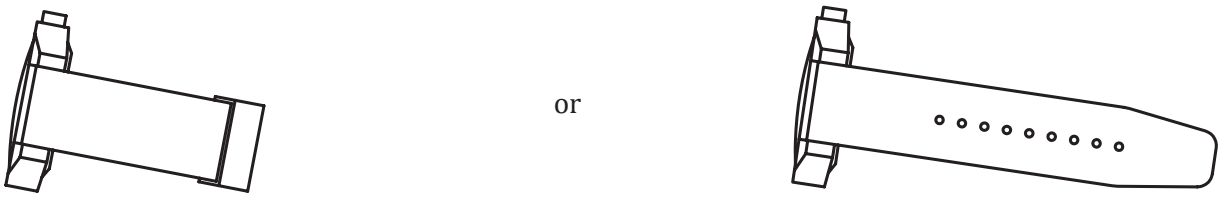


Figure 6 — Watch position for first free-fall shock

5.3.3 Second free fall

The complete watch shall be put in the bracelet down starting position with open clasp. See Figure 7.

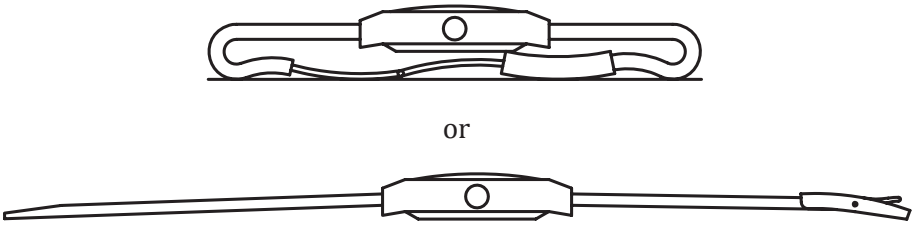


Figure 7 — Watch position for second free-fall shock

When bracelet shape or material does not allow one of the positions described in Figure 7, a technical solution shall be used to maintain the watch into CH position. This solution shall not influence the free fall.

5.3.4 Requirements after free-fall shocks

— The examination of the watch bracelet or watch strap shall not reveal any broken or lost components.

— Bracelet attachments to the watch head as well as the bracelet clasps, buckles or any other outer functional element of the complete watch, shall remain functional.

6 Marking

Watches which satisfy the minimum requirements specified in this International Standard may be marked as follows:

— “shock-resistant”, in English;

— “résistant aux chocs”, in French;

— “ противоударные”, in Russian;

— “stoßsicher”, in German;

— “ 耐衝撃 ”, in Japanese;

— “ 防震 ”, in Chinese.

Annex A
(normative)

Shocks characteristics verification

A.1 General

It is important to initially and periodically verify the characteristics (i.e. mainly the intensity and duration) of the shocks generated by the apparatus on the watch to ensure proper repeatability of the test, especially versus possible sabot degradation.

Since the shape, the mass and the material of the watch influence the shocks characteristics themselves, the shocks shall be verified by applying the test procedure specified in chapter 5.2.2 and 5.3.2 to the test sample specified in A.2.

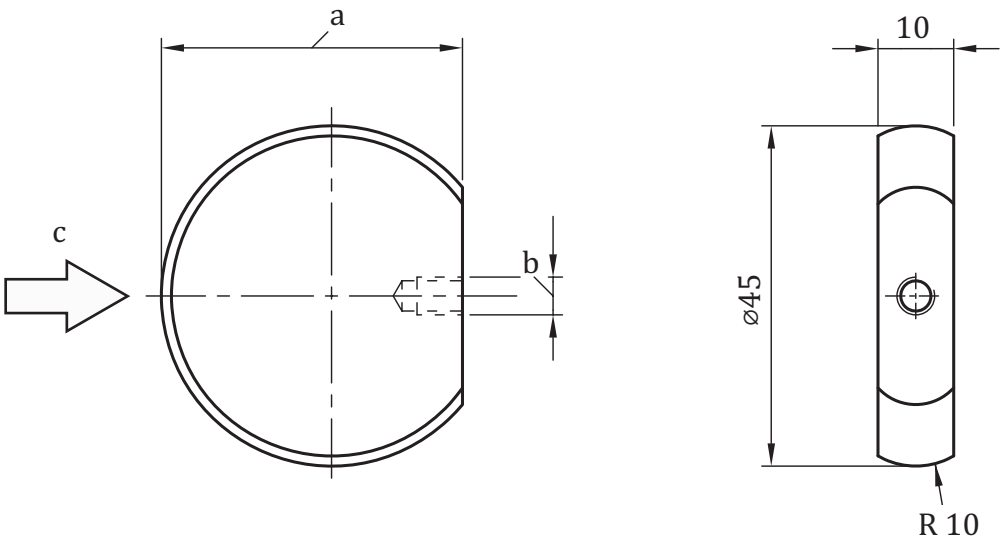
A.2 Test sample

The test sample shall comply with the following specifications (see Figure A.1).

Material: Stainless Steel, X10CrNiS18-9

Mass: 0,100 kg ± 0,002 kg (including any attached part used to measure the acceleration, e.g. a capacitive accelerometer)

Dimensions in millimetres



Key

a Adjust to meet specified mass.

b Thread allowed for sensor binding.

c Impact point and direction.

Figure A.1 — Test sample specifications

A.3 Shock shape

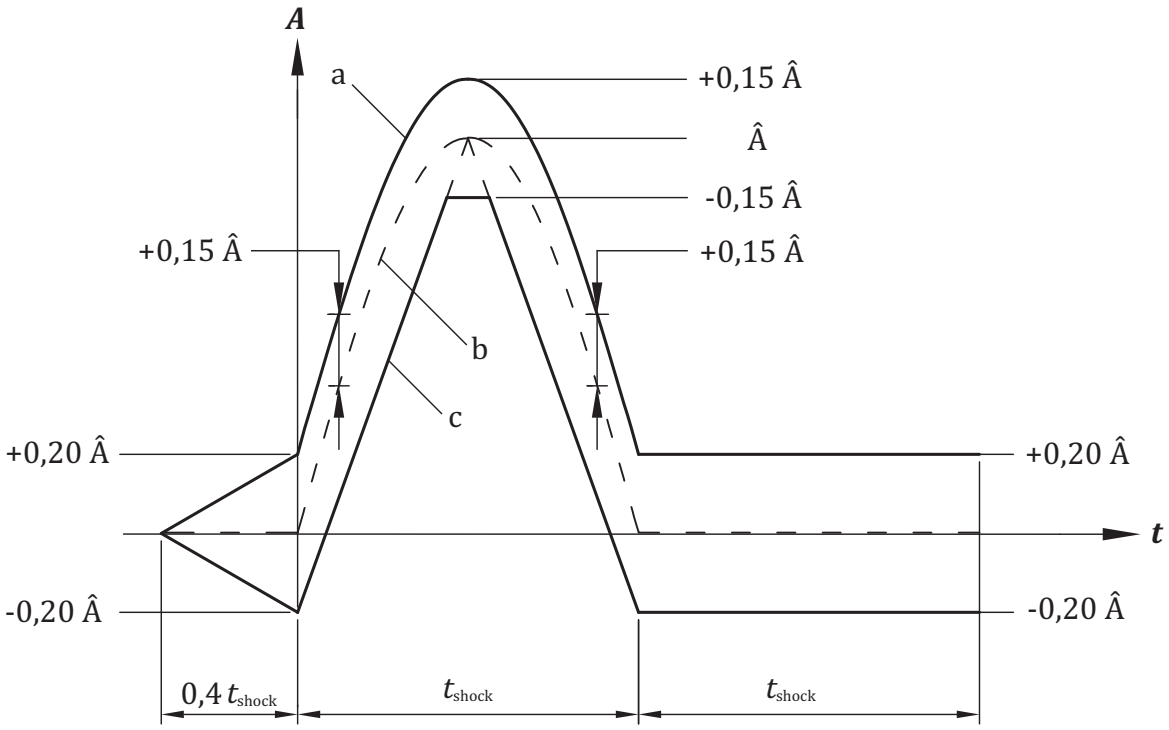
The acceleration applied onto the test sample specified in A.2 by the test apparatus and procedures specified in 5.2.2 and 5.3.2 shall meet the following envelope (see Figure A.2)

where

t_{shock} = 350 µs;

Â = 3 100 g.

NOTE The gravity of the earth is noted in "g" and is equal to 9,81 m/s^2.



Key

A	acceleration
Â	maximum shock acceleration
t	time
t_{shock}	shock duration

a Max (Half Sine) $A(t) = Â(0,2 + 0,95 \sin(\pi \frac{t}{t_{shock}}))$

b Typ. (Half Sine) $A(t) = Â \sin(\pi \frac{t}{t_{shock}})$

c Min (Triangle)

Figure A.2 — Shock shape envelope

A.4 Bandwidth

To ensure proper measurement of the acceleration, the measuring setup shall have a minimum bandwidth of 20 Hz to 20 kHz within ±3 dB.

Annex B
(informative)

Example of apparatus for three first shocks (shock test apparatus)

B.1 Characteristics of apparatus for first, second and third shocks

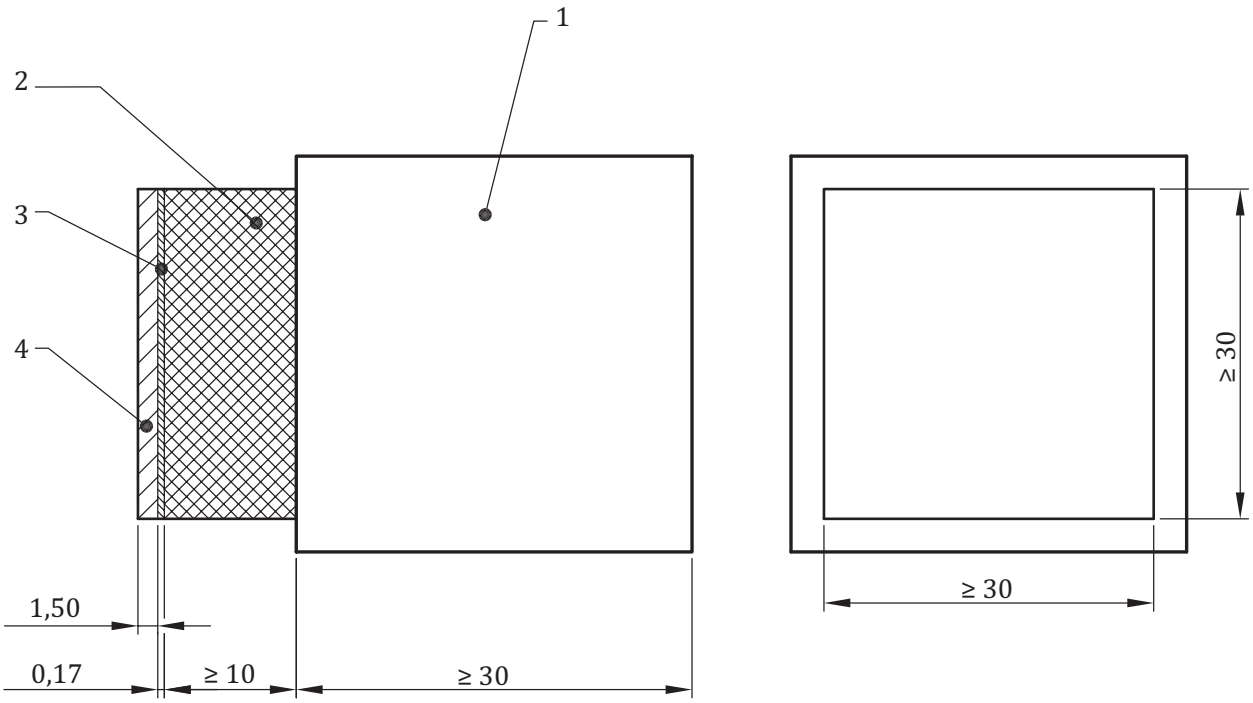
B.1.1 Hammer and sabot

The part of the hammer striking the watch (the composite sabot) shall be made according to Figure B.1.

The dimensions of the sabot should be as shown in Figure B.1.

The total mass of the hammer, including the sabot, should be at least 3 kg.

Dimensions in millimetres



Key

1 hammer

2 POM[a] shock absorber

3 acrylic double coated tape[b]

4 PUR[c] shock transmitter

a Thermoplastic polyoxymethylene (polyacetal) copolymer POM C available as SUSTARIN C from Roechling.[1)]

b Acrylic double coated thin film tape available as 3M Double Coated Tape 9495LE.[1)]

c Polyurethane-elastomere PUR available as Vulkollan from Bayer AG.[1)]

1) SUSTARIN C from Roechling (http://www.roechling.com/), 3M Double Coated Tape 9495LE (http://www.3m.com/), and Vulkollan from Bayer AG (http://www.bayer.com/) are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products. Equivalent products may be used if they can be shown to lead to the same results.

Figure B.1 — Sabot composition

The composite sabot configuration is a recommendation to realize the shock shape envelope according to A.3. Since the composite sabot as shown is subject to natural alteration, it shall be verified initially and periodically to comply with A.3.

B.1.2 Starting position of hammer

The angle α, giving the starting position of the hammer (see Figure B.2), should be calculated using the following formula:

$$\cos\frac{\alpha}{2} = \frac{vT}{4\pi \cdot r} \tag{B.1}$$

where

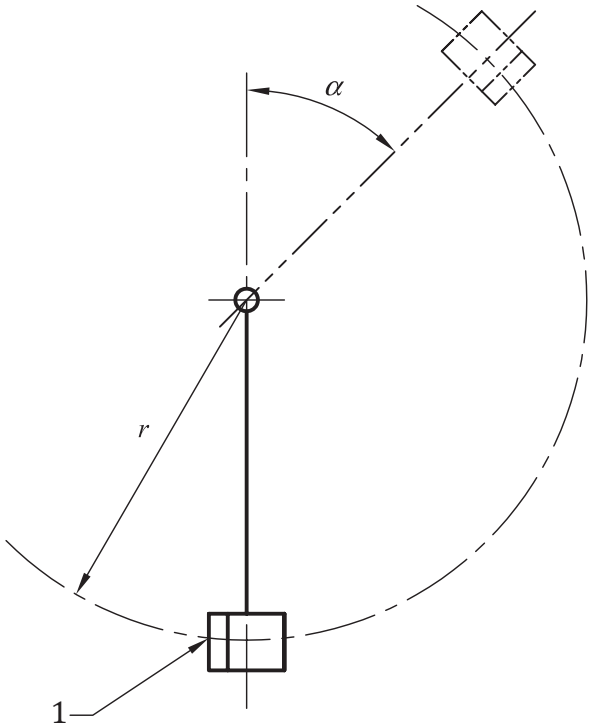
α is the angle, from vertical, of the starting position of the hammer;

v is the impact speed, v = 4,43 m/s corresponding to an unimpeded fall from a height of 1 m;

T is the period, in seconds;

r is the radius, in meters.

These last two values are determined by the manufacturer of the shock test apparatus impact tester.



Key

1 shock point

Figure B.2 — Starting position

The period T represents the duration, in seconds, of one oscillation of low amplitude (see Figure B.3).

$$\beta_{max} = 10° \quad \text{(B.2)}$$

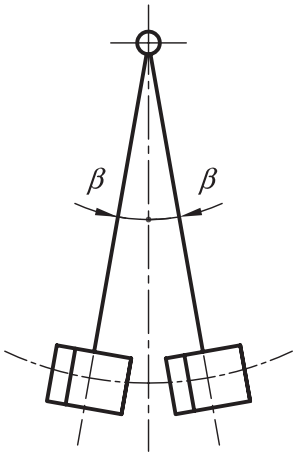
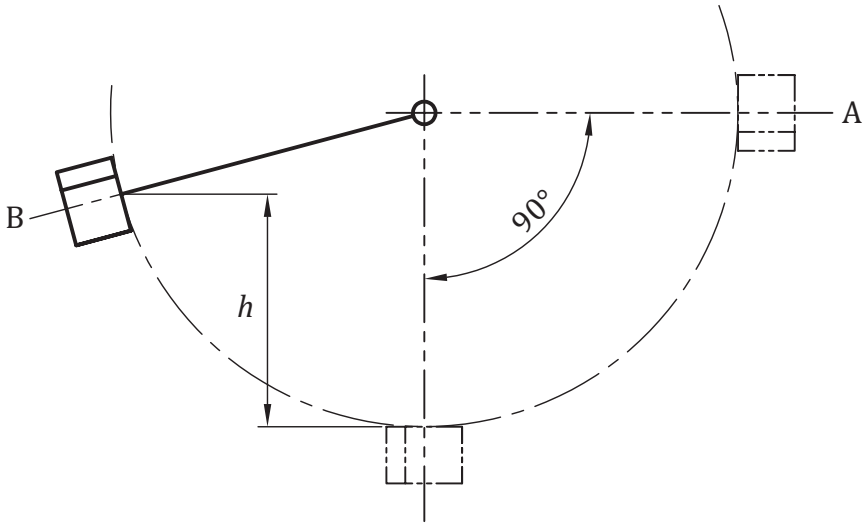


Figure B.3 — Duration of one oscillation

B.1.3 Working check

Before performing any tests, the proper function of the hammer shall be checked. The check should be carried out with the hammer freely oscillating.

The manufacturer of the shock test apparatus impact tester should state the minimum height h (see Figure B.4) corresponding to the ascent of the hammer to position B after starting in position A (horizontal). If this height h is not reached, the shock test apparatus impact tester should be checked.



Key

A starting position (horizontal)

B ascent of the hammer (minimum height)

Figure B.4 — Determination of minimum height

B.1.4 Position of watch head

The watch head should be laid freely on its horizontal support to be subjected to the three shocks indicated in 5.2.

The positioning of the watch head on this support should be such that the shock is produced at the exact instant when the shock test apparatus passes through its point of stable equilibrium.

B.1.5 Condition of shock

At the moment of impact, the face of the sabot coming into contact with the watch should be vertical and parallel to the vertical plane containing the axis of oscillation of the shock test apparatus.

B.1.6 Arresting device applied to the watch after shock

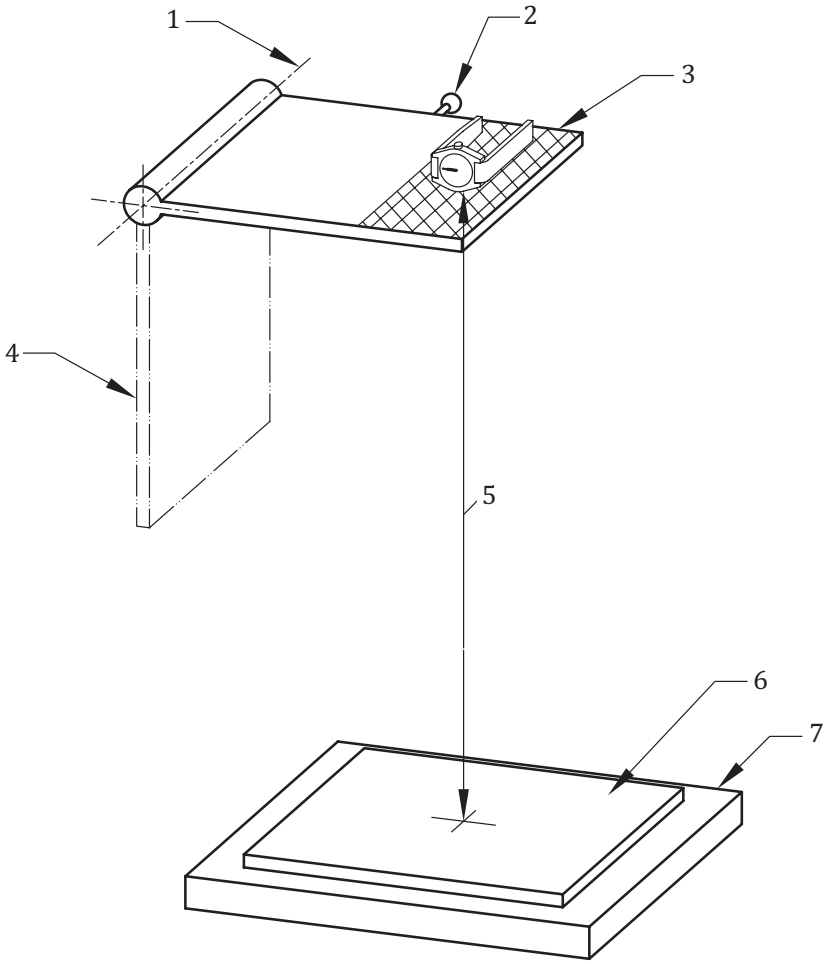
After the shock, the watch shall swing freely along its trajectory and shall be gradually stopped by a device (cushion) which does not add any further shock.

Annex C
(informative)

Example of test apparatus for free-fall shock

C.1 Characteristics of apparatus for free-fall shocks

C.1.1 Schematic diagram



Key

1 rotation axis of trap door
2 release button for trap door
3 closed position
4 open position
5 free-fall height (see 4.4.3)
6 impact plate
7 metal base plate

Figure C.1 — Equipment overview

The impact surface characteristics shall comply with the shock envelope specified in A.3. The materials used for the impact plate (Figure C.1, key item 6) may be as described in B.1.1. The test sample shall be as described in A.2.

C.1.2 Dimension of the trap door

The trap door shall be 14 cm × 24 cm.

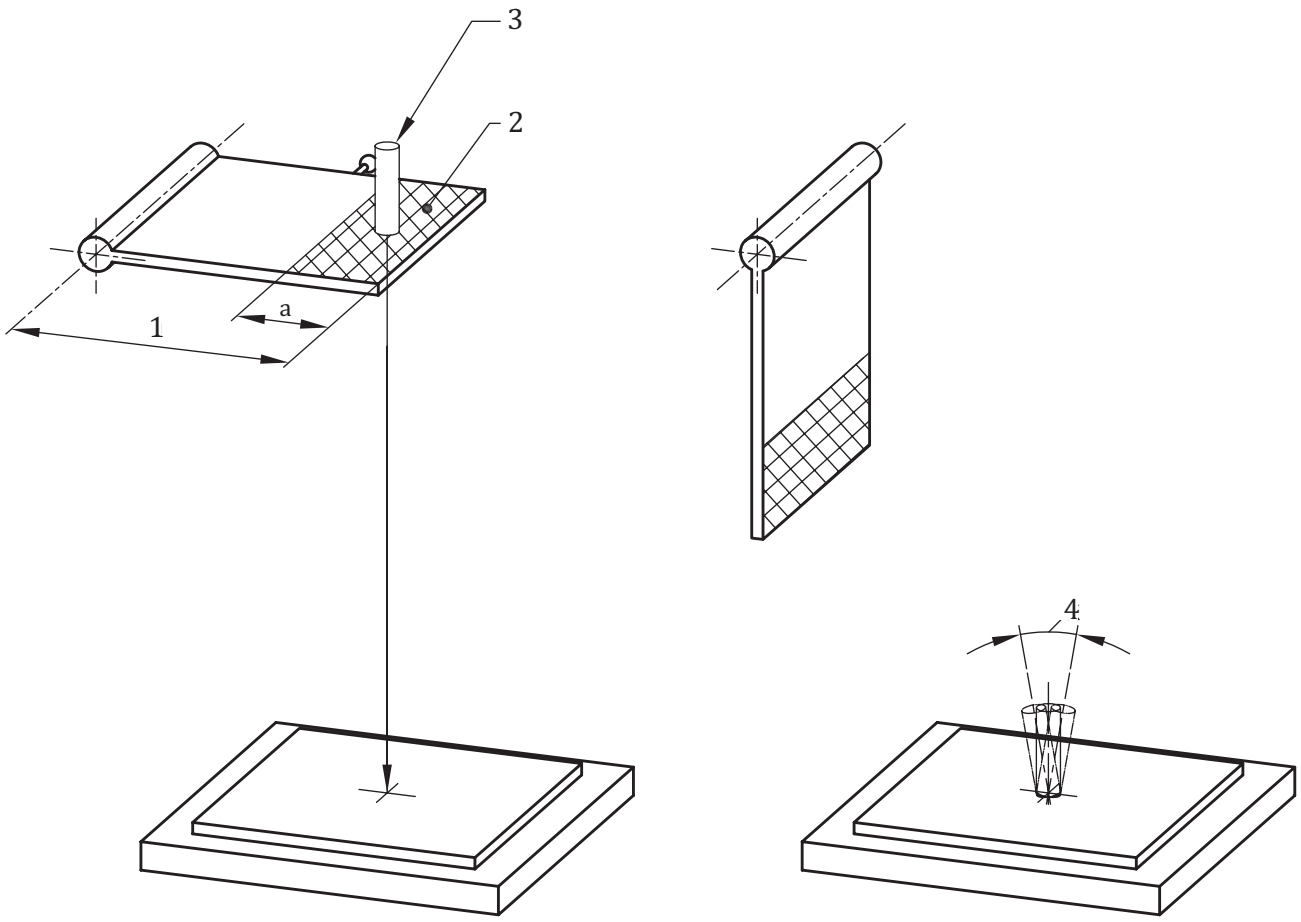
C.1.3 Working check of the trap door

In order to achieve an unaffected release and start into free-fall of the test sample, it is recommended that the following conditions (see Figure C.2) are verified periodically.

— At the start phase of the pivoting movement, the snap lid rotation may be accelerated with a suitable element such as a spiral spring, a rubber band or any properly placed other element in order to avoid any influence on the direction of the watch during the free fall.

— The snap lid may be perforated to reduce air resistance during the pivoting movement.

— After the release of the mechanism, followed by the free-fall of 1 m, the test cylinder should remain in a vertical position at the moment of impact.



Key

1 snap lid length (24 cm)
2 working surface according to C.1.3
3 calibration cylinder (⌀15 mm in diameter, 65 mm in length)
4 tolerance ±10° arc
a One-third of the snap lid length.

Figure C.2 — Equipment working check

C.1.4 Calibration

In order to verify the shock shape (A.3), the wire (Figure C.3, key item 4) shall be high enough (Figure C.3, key item 5) to guarantee that it does not influence the free fall.

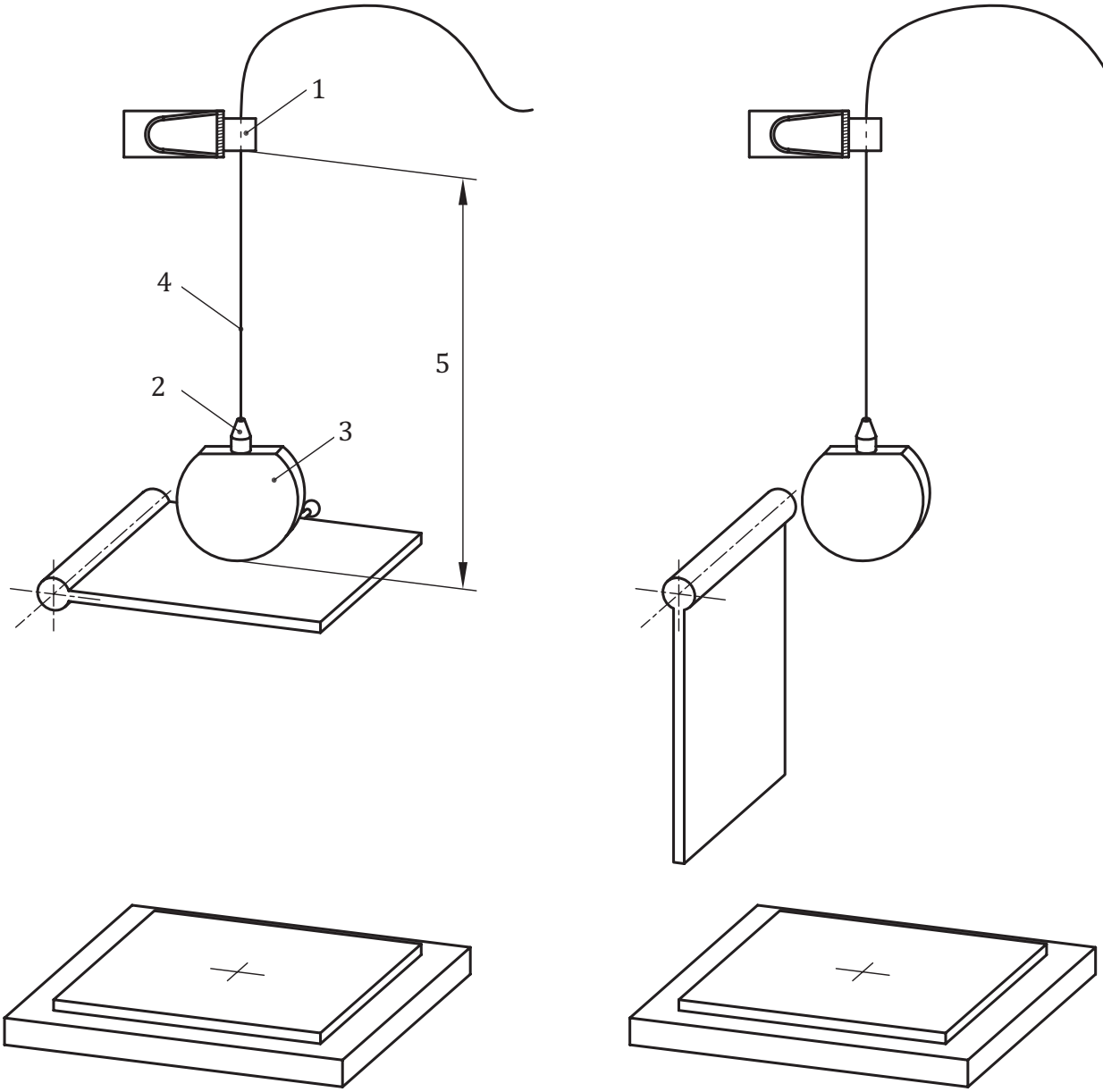
The calibration sequence should be performed as follows.

a) Put the test sample on the closed trap door.

b) Attach the wire to the clamp (wire shall be tense).

c) Open the trap door.

d) Release the wire (clamp opening).



Key

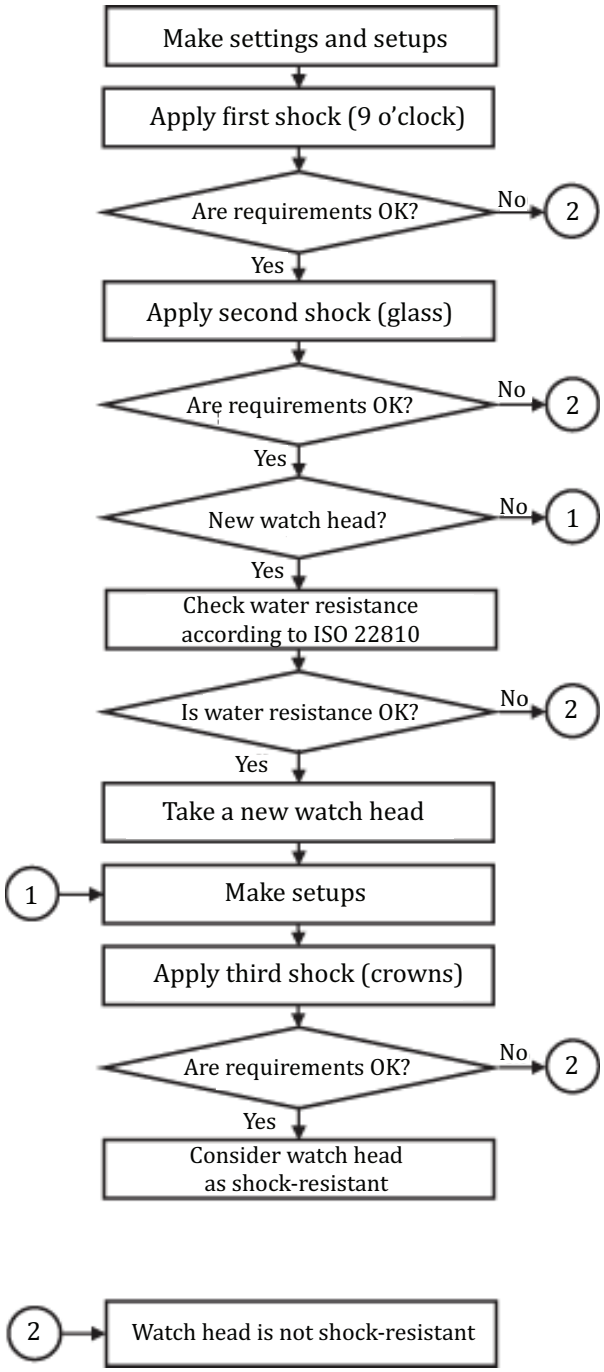
1 clamp
2 acceleration detector
3 test sample according to A.2
4 wire (as thin as possible)
5 minimum 1 m high

Figure C.3 — Calibration sequence

Annex D
(normative)

Flow charts

D.1 Flow chart for test procedure applicable to functional watch heads



According to 4.5 and 5.2.1.

According to 5.2.2.1.

According to 5.2.2.2.

According to 5.2.3.1.

According to 5.2.3.2.3 and 5.2.3.2.4.

Check whether a new watch head should be used for the third shock (according to 5.1).

If applicable, check water-resistance on the first watch head according to 5.2.3.2.5.

According to 5.2.3.2.5.

According to 5.2.4.2.

According to 5.2.4.2.

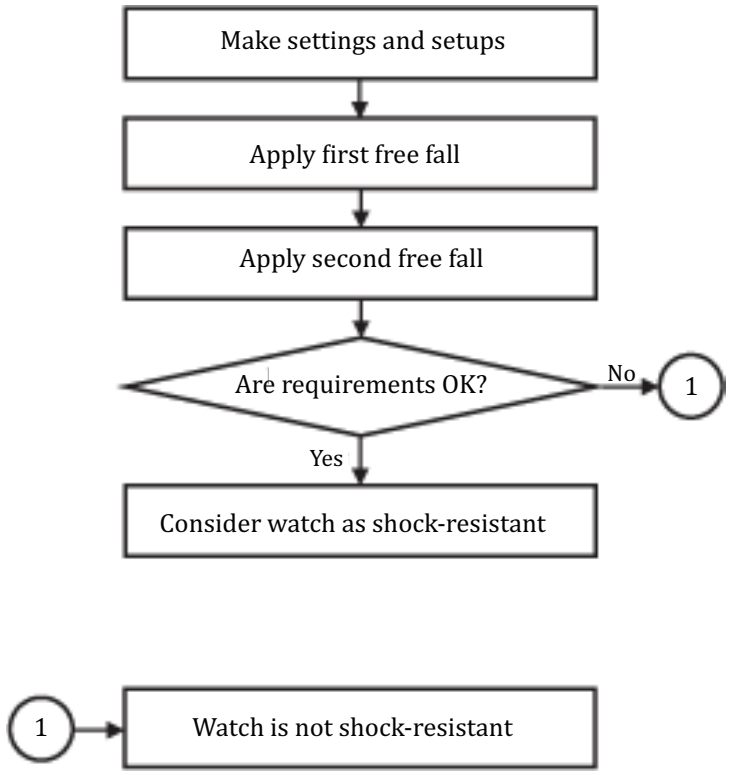
According to 5.2.4.3.

All tests passed successfully.

The watch head shall be considered as "shock-resistant".

The watch head is not "shock-resistant".

D.2 Flow chart for free-fall test procedure to complete watches with bracelet



According to 5.3.1.

According to 5.3.2.

According to 5.3.3.

According to 5.3.4.

All tests passed successfully. The watch shall be considered as “shock-resistant”.

The watch is not “shock-resistant”.

Annex E
(informative)

Shock description and consequences of exposure

E.1 Shock description

This term determines a collision between two objects resulting in a strike or clash between these objects. In the context of this International Standard, the watch collides with a wooden floor after a free-fall of one meter, having a shock effect on the watch due to the impact with the floor.

Based on the theory of momentum, the hammer of the shock test apparatus (see Annex B), being a moving body under the influence of gravity, having a momentum (vector p = mv), collides with the watch head which is in a state of rest. At the moment of impact, the watch head is accelerated by the force exerted by the elastic shock of the hammer. The watch head is therefore put in motion, adopting its own momentum.

In the free-fall test sequence (see Annex C), the watch is released from rest. Gravity accelerates the watch towards the impact surface. At the moment of impact, the watch head is exposed to a negative acceleration, exerted by the force of the impact surface during the shock.

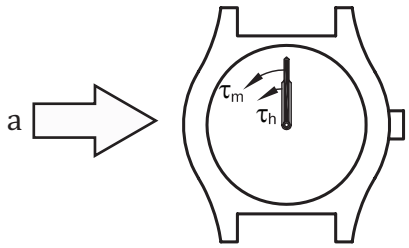
E.2 Consequences of shock exposures

The linear shocks applied to the watch head, as well as the free fall from a 1 m height of the complete watch, represent very high constraints for all watch components exposed. Depending on the total mass of the watch, their constructive placement, the geometry, the materials used and functions required by the components, linear accelerations can be observed and measured.

Therefore every shock applied within this International Standard significantly weakens the components and brings them closer to the state of overload and finally to a complete breakdown. This phenomenon and the consequences of a steady stress accumulation are the reasons why the acceptance criteria take place in a selective way, observing the residual effects after each test sequence.

E.3 Time setting observations

Prior to the first shock according to 5.2.2, the time should be set at 12 o'clock since the perpendicular shock against the 9 o'clock side of the watch causes a total torque of $\tau_{tot} = \tau_m + 1/12\tau_h$ = torque of the minute hand + torque of the hour hand, transmitted by the minute wheel to the canon-pinion axis.



$$\tau_{tot} = \tau_m + \frac{1}{12}\tau_h$$

Key

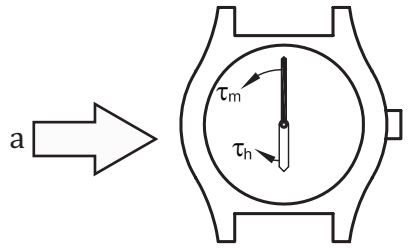
a Shock.

Figure E.1 — 12 o'clock time setting hands position

NOTE The frictions of the gear wheels are neglected.

The friction wheel shall withstand to τ_{tot}, insuring a maximum displacement of the minute hand at < 5 min as specified in 5.2.2.2.

The initial time setting position at 6 o'clock is not allowed due to the reduction of the total torque, τ_{tot}, by the hour hand torque, τ_h.



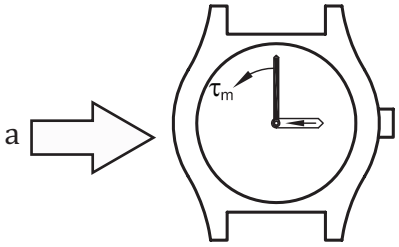
$$\tau_{tot} = \tau_m - \frac{1}{12}\tau_h$$

Key

a Shock.

Figure E.2 — 6 o'clock time setting hands position

The initial time setting positions at 3 or 9 o'clock are not allowed due to absence of the hour hand torque. Only the minute wheel hand torque, τ_m, is present.



$$\tau_{tot} = \tau_m (\tau_h = 0)$$

Key

a Shock.

Figure E.3 — 3 o'clock time setting hands position

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[1] ISO 6425, *Divers' watch*

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[3] ISO 14120, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

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