INTERNATIONAL STANDARD

# ISO 9022-22

First edition
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# Optics and photonics — Environmental test methods —

## Part 22: Combined cold, dry heat or temperature change with bump or random vibration

*Optique et photonique — Méthodes d'essais d'environnement —*

*Partie 22: Chaleurs sèche, froid ou changement de température combinés avec choc ou vibration aléatoire*

Reference number
ISO 9022-22:2012(E)

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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 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9022-22 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

This first edition cancels and replaces ISO 9022-10:1998, ISO 9022-13:1998, ISO 9022-15:1998, ISO 9022-16:1998 and ISO 9022-19:1994 which have been technically revised.

ISO 9022 consists of the following parts, under the general title *Optics and photonics — Environmental test methods*:

— *Part 1: Definitions, extent of testing*

— *Part 2: Cold, heat and humidity*

— *Part 3: Mechanical stress*

— *Part 4: Salt mist*

— *Part 5: Combined cold, low air pressure*

— *Part 6: Dust*

— *Part 7: Resistance to drip or rain*

— *Part 8: High pressure, low pressure, immersion*

— *Part 9: Solar radiation*

— *Part 11: Mould growth*

— *Part 12: Contamination*

— *Part 14: Dew, hoarfrost, ice*

— *Part 17: Combined contamination, solar radiation*

— *Part 18: Combined damp heat and low internal pressure*

— *Part 20: Humid atmosphere containing sulfur dioxide or hydrogen sulfide*

— *Part 21: Combined low pressure and ambient temperature or dry heat*

— *Part 22: Combined cold, dry heat or temperature change with bump or random vibration*

— *Part 23: Low pressure combined with cold, ambient temperature and dry or damp heat*[1)]

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1) Under preparation.

# Introduction

Optical and photonic instruments, including additional assemblies from other fields (e.g. mechanical, chemical and electronic devices) are affected during their use by a number of different environmental and handling parameters which they are required to resist without significant reduction in performance, while still remaining within defined specifications.

The type and severity of these parameters depend on the conditions of use of the instrument (for example in the laboratory or workshop) and on its geographical location. The environmental effects on optical instrument performance in tropical and subtropical climates are totally different from those found when they are used in the arctic regions. Individual parameters cause a variety of different and overlapping effects on instrument performance.

The manufacturer attempts to ensure, and the user naturally expects, that instruments will resist the likely rigours of their environment throughout their life. This expectation can be assessed by cumulated exposure of the instrument to a range of simulated environmental parameters under controlled laboratory conditions. The cumulative combination, degree of severity and sequence of these conditions can be selected to obtain meaningful results in a relatively short period of time.

In order to allow assessment and comparison of the response of optical instruments to appropriate environmental conditions, the ISO 9022 series contains details of a number of laboratory tests which reliably simulate a variety of different environments. The tests are based largely on IEC standards, modified where necessary to take into account features specific to optical instruments.

It should be noted that, as a result of continuous progress in all fields, optical instruments are no longer only precision-engineered optical products, but, depending on their range of application, also contain additional assemblies from other fields. For this reason, the principal function of the instrument must be assessed to determine which International Standard should be used for testing. If the optical function is of primary importance, then the relevant part of ISO 9022 is applicable, but if other functions take precedence, then the appropriate International Standard in the field concerned should be applied. Cases may arise where application of both the relevant part of ISO 9022 and other appropriate International Standards is necessary.

# Optics and photonics — Environmental test methods —

# Part 22:
# Combined cold, dry heat or temperature change with bump or random vibration

## 1 Scope

This part of ISO 9022 specifies methods for the testing of optical instruments, including additional assemblies from other fields (e.g. mechanical, chemical and electronic devices) under equivalent conditions, for their ability to resist combined bump or random vibration, in cold, dry heat or temperature change.

The purpose of testing is to investigate to what extent the optical, thermal, chemical and electrical performance characteristics of the specimen are affected by combined cold, dry heat or temperature change with bump or random vibration.

## 2 Normative references

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

ISO 9022-1, *Optics and photonics — Environmental test methods — Part 1: Definitions, extent of testing*

ISO 9022-2, *Optics and optical instruments — Environmental test methods — Part 2: Cold, heat and humidity*

ISO 9022-3, *Optics and optical instruments — Environmental test methods — Part 3: Mechanical stress*

IEC 60068-2-47, *Environmental testing — Part 2-47: Tests — Mounting of specimens for vibration, impact and similar dynamic tests*

IEC 60068-2-64, *Environmental testing — Part 2-64: Tests — Test Fh: Vibration, broadband random and guidance*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9022-1 apply.

## 4 General information and test conditions

Exposure of the specimen to combined stress conditions renders the test much more severe than separate exposure to any of the environmental conditions cited. Stress conditions such as cold, dry heat or temperature change, combined with bump or random vibration, correspond to real conditions under use. In the case of the lifetime test, tests with higher degrees of severity for time reduction, damage-provoked tests, etc., combined test methods such as Burn-In, Run-In or Environmental Stress Screening (ESS) are useful.

Burn-In, Run-In or ESS are test methods for optical instruments and instruments containing optical components and/or their electronic assembly, in which the system is switched off or in operation, and exposed to their operating, storage, shipping or other temperature cycles, combined with sinusoidal or random vibration and operation with under or excess voltage.

The aforementioned methods of combined tests are suitable to force potential faults to be detected during first use and to eliminate them before delivery. There are stress factors with different impacts. The choice of combination of test methods should be specific to the products and is therefore not standardized.

The values of temperatures specified in Table 1 are selected from ISO 9022-2, conditioning methods 10, 11 and 14.

The values of mechanical loads specified in Table 1 are selected from ISO 9022-3, conditioning methods 31 and 37.

Conditioning methods 10, 11 or 14 are combined with conditioning methods 31 or 37. Combinations are listed in Table 1.

Testing shall be conducted in accordance with the requirements of ISO 9022-3.

The fixture for the specimen shall meet the requirements of IEC 60068-2-47 and shall be thermally insulated, if appropriate.

If the specimen is mounted on shock absorbers, time shall be allowed for temperature stabilization of the absorber elements.

For the purposes of this part of ISO 9022, the value of $g_n$ is rounded up to the next highest integer, i.e. 10 m/s$^2$.

# 5 Conditioning

## 5.1 General

If temperature change testing is performed, the required exposure time starts with the beginning of temperature change. The temperature of the specimen and of the test chamber shall be the same.

When testing optical instruments, a half-sine shock pulse shall be applied. The specimen shall be subjected to one thousand shocks in each direction along each axis or a specific number of shocks shall be defined.

Random vibration shall be digitally controlled. The acceleration power spectral density shall be controlled with a vibration control system according to IEC 60068-2-64.

Other parameters such as temperature, cold or dry heat, temperature change, type of random vibration, exposure time to temperature, exposure time to vibration, number of shocks, repetition frequency of shocks, axis of bump or random vibration, state of operation, etc., shall be defined in the relevant specification.

## 5.2 Conditioning method 22: Cold, dry heat or temperature change combined with bump or random vibration

See Table 1.

**Table 1 — Degrees of severity for conditioning method 22: Cold, dry heat or temperature change combined with bump or random vibration**

| **Parameters to be defined in the relevant specification** | | **Bump:**<br>10 $g_n$, 6 ms<br>(ISO 9022-31-01)[a] | **Random vibration:**<br>20 Hz to 150 Hz<br>0,02 $g_n^2$/Hz<br>(ISO 9022-37-01) | **Random vibration:**<br>20 Hz to 500 Hz<br>0,005 $g_n^2$/Hz<br>(ISO 9022-37-11) | **Random vibration:**<br>20 Hz to 2 000 Hz<br>0,001 $g_n^2$/Hz<br>(ISO 9022-37-21) |
|---|---|---|---|---|---|
| **Cold:** | −10 °C<br>(ISO 9022-10-02) | Exposure time to temperature<br>Number of shocks<br>Repetition frequency of shocks | Exposure time to temperature<br>Exposure time to vibration | | |
| | −25 °C<br>(ISO 9022-10-05) | | | | |
| | −35 °C<br>(ISO 9022-10-07) | | | | |

[a] Environmental test code (see Clause 7).

**Table 1** *(continued)*

| Parameters to be defined in the relevant specification | | Bump:<br>10 $g_n$, 6 ms<br>(ISO 9022-31-01)[a] | Random vibration:<br>20 Hz to 150 Hz<br>0,02 $g_n^2$/Hz<br>(ISO 9022-37-01) | Random vibration:<br>20 Hz to 500 Hz<br>0,005 $g_n^2$/Hz<br>(ISO 9022-37-11) | Random vibration:<br>20 Hz to 2 000 Hz<br>0,001 $g_n^2$/Hz<br>(ISO 9022-37-21) |
|---|---|---|---|---|---|
| Dry heat: | 40 °C<br>(ISO 9022-11-02) | Exposure time to temperature<br>Number of shocks<br>Repetition frequency of shocks | Exposure time to temperature<br>Exposure time to vibration | | |
| | 55 °C<br>(ISO 9022-11-03) | | | | |
| | 63 °C<br>(ISO 9022-11-04) | | | | |
| Temperature change: | –10 °C/40 °C<br>(ISO 9022-14-01) | Number of temperature cycles<br>Number of shocks<br>Repetition frequency of shocks | Number of temperature cycles<br>Exposure time to vibration | | |
| | –25 °C/55 °C<br>(ISO 9022-14-02) | | | | |
| | –35 °C/63 °C<br>(ISO 9022-14-05) | | | | |

[a] Environmental test code (see Clause 7).

# 6 Procedure

## 6.1 General

The tests shall be conducted in accordance with the requirements of the relevant specification and the reference documents.

## 6.2 Test sequence with cold or dry heat testing

Specimens may be repositioned for shock or vibration along another axis, at any temperature between ambient and test chamber temperature, provided that there is no formation of condensation, hoarfrost or ice.

## 6.3 Test sequence with temperature change

The first temperature cycle commences at ambient atmospheric conditions. The duration of a cycle is normally between 7 h and 8 h, regardless of temperature differences within the cycles, depending on the required severity. The mean heating and cooling rate of the chamber shall allow a continuous variation of temperature at the specimen (see Figure 1) or shall be stipulated in the relevant specification.

NOTE Conditioning method 14 of ISO 9022-2 specifies a test chamber temperature rate of change in the range between 0,2 K and 2 K per minute. However, higher rates may be appropriate depending on the individual application. Rates of 1 K per minute to 10 K per minute have proven to be convenient in practical application.

Specimens may be repositioned for shock or vibration along another axis, at any temperature between ambient and test chamber temperature, provided that there is no formation of condensation, hoarfrost or ice.

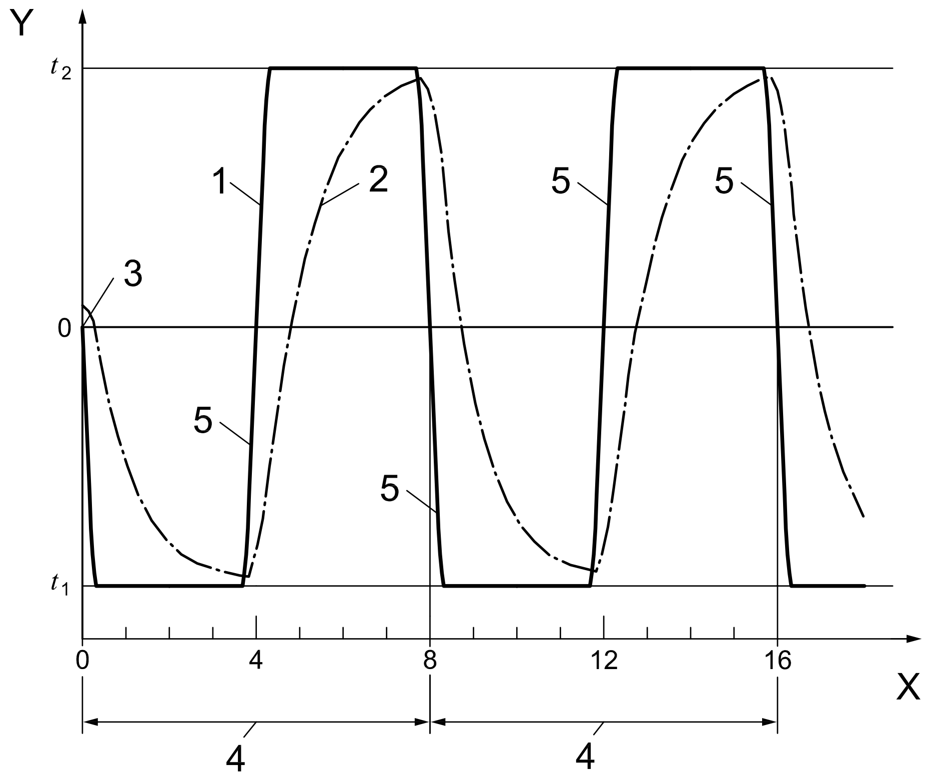
## 6.4 Operating condition of specimen

In the case of electrically operated specimens, the times at which the power supply is connected or disconnected and the voltage of the power supply within each temperature cycle shall be specified in the relevant specification.

The times at which other functions such as cooling, heating and various loads are switched on or off shall be stipulated in the relevant specification or controlled by a special type of test equipment.

### 6.5 Mechanical conditioning of specimen

If the specimen is operated by power supply, this shall be connected for the duration of the mechanical conditioning.




**Key**

X duration, h

Y test chamber temperature, °C

1 temperature of the chamber

2 temperature of the specimen

3 ambient temperature

4 temperature cycle (1st, 2nd, etc)

5 rate of temperature change, typically between 1 K and 10 K per minute

**Figure 1 — Schematic representation of course of first two temperature cycles for temperature change with duration of 8 h per cycle**

## 7 Environmental test code

The environmental test code shall be as defined in ISO 9022-1.

EXAMPLE The environmental test of optical instruments for resistance to combined temperature change, conditioning method 14, degree of severity 01, state of operation 1 and random vibration, conditioning method 37, degree of severity 01, state of operation 1, shall be identified as:

**Environmental test ISO 9022-22-14-01/37-01-1**

## 8 Specification

The relevant specification shall contain the following details:

a) environmental test code;

b) exposure time to temperature;

c) test chamber temperature change rate;

d) dwell time at temperatures;

e) temperature difference;

f) number of temperature cycles;

g) exposure time to vibration;

h) number of shocks;

i) repetition frequency of shocks;

j) shock axis and directions;

k) state of operation;

l) number of specimens;

m) humidity, if relevant for combined test;

n) preconditioning;

o) type and scope of initial test;

p) state of operation 2: period of operation;

q) state of operation 2: type and scope of intermediate test;

r) recovery;

s) type and scope of final test;

t) criteria for evaluation;

u) type and scope of test report.

# Annex A
(informative)

# Explanatory notes

A statistical evaluation of the results of similar or identical tests performed over many years has shown that these tests provide a relatively economical means of estimating the frequency of instrument failure.

The special value of these tests lies in the following.

**A.1** It is possible at the development stage of instruments, to optimize materials, components and assemblies regarding reliability and instrument maintenance, and to recognize at an early stage their possible failure in long-term use. At this stage, it is advisable to test materials, components and assemblies rather than the complete instrument. By testing sufficient numbers, especially at the beginning of production (pilot run), further weaknesses in the assembly can be discovered and eliminated. The failure level which is to be expected in long-term use is decreased, and quality and reliability are improved.

**A.2** The test is also suitable for monitoring production. For operative components and complete instruments alike, production-related defects or inaccuracies of a mechanical, electrical or optical nature can be recognized at an early stage and the quality of production thus improved.

**A.3** The results of the test described in A.1 and A.2 can be used to derive instrument-specific endurance conditioning for the elimination of early failures and for the deliberate generation of ageing effects.

# Bibliography

[1] IEC 60068-2-27, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock*

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