IEC 60068-2-14

Edition 7.0 2023-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Environmental testing –
Part 2-14: Tests – Test N: Change of temperature**

**Essais d'environnement –
Partie 2-14: Essais – Essai N: Variation de température**

IEC 60068-2-14:2023-07(en-fr)

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ENVIRONMENTAL TESTING –

Part 2-14: Tests – Test N: Change of temperature

FOREWORD

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IEC 60068-2-14 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test. It is an International Standard.

This seventh edition cancels and replaces the sixth edition published in 2009. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) updating of the figures for clarification purposes;
b) updating of specimen temperature(s) and severities as well as tolerances for change of temperature tests;
c) revision of standardized requirements for test reports for Tests Na and Nb.

The text of this International Standard is based on the following documents:

Draft	Report on voting
104/991/FDIS	104/1016/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60068 series, published under the general title *Environmental testing*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

A change of temperature test is intended to determine the effect on the specimen of a change of temperature or a succession of changes of temperature.

It is not intended to show effects that are caused by low or high temperature exposure. For these effects, the cold test or the dry heat test, as specified in IEC 60068-2-1 and IEC 60068-2-2, should be used.

The effect of change of temperature tests is determined by

- values of high and low conditioning temperature between which the change is to be affected,
- the conditioning times for which the test specimen is kept at these temperatures,
- the rate of change between these temperatures,
- the number of cycles of conditioning,
- the amount of heat transfer into or from the specimen,
- the thermal conductivity and the materials of the specimen,
- the rate of change of the specimen’s temperature on its surface (respectively in relevant positions) or in its core.

Guidance on the choice of suitable test parameters for inclusion in the detail specification is given throughout this document.

ENVIRONMENTAL TESTING –

Part 2-14: Tests – Test N: Change of temperature

1 Scope

This document provides tests with specified ambient temperature changes to analyse their impacts on specimens.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60068-2-1 and IEC 60068-2-2 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

4 Symbols

D	temperature difference between high conditioning temperature T_B and low conditioning temperature T_A
T_A	low conditioning temperature
T_{Ad}	decreased low conditioning temperature
T_B	high conditioning temperature
T_{Bi}	increased high conditioning temperature
T_{STD}	temperature of standard atmospheric conditions for measurement and tests (15 °C to 35 °C)
ΔT_s	temperature difference between the specimen and the test medium (e.g. air)
dT_R	temperature change rate (Test Nb)
t_s	stabilization time of specimen temperature
t_{s*}	stabilization time of specimen temperature during the first cycle, starting from laboratory air temperature
t_1	exposure time of the specimen to each conditioning temperature
t_2	transfer time of the specimen from one test chamber to another (two-chamber test method)
$\pm\sigma_T$	applicable temperature tolerance of the medium temperature during temperature transition (Test Nb)
$\pm\sigma_{Tconst}$	applicable temperature tolerance of the medium temperature during the constant conditioning

5 General

5.1 Field conditions of changing temperature

It is common in electronic equipment and components that changes of temperature occur. Parts inside equipment undergo slower changes of temperature than those on an external surface when the equipment is not switched on.

Rapid changes of temperature can be expected

– when equipment is transported from warm indoor into cold outdoor environments or vice versa,
– when equipment is suddenly cooled by rainfall or immersion in cold water,
– when equipment is attached or in close proximity to components leading to high thermal stress (e.g. combustion engines, central processing units),
– when equipment is artificially cooled or heated,
– in externally mounted airborne equipment or when equipment is located in unheated aircraft or cargo holds,
– under certain conditions of transportation and storage.

Components will undergo stresses due to changing temperature when high temperature gradients build up in an equipment after being switched on, for example in the proximity of high power resistors, radiation can cause rise of the surface temperature on close components while other portions remain cold.

Artificially cooled components can be subjected to rapid temperature changes when the cooling system is switched on. Rapid changes of temperature in components can also be induced during manufacturing processes or the transportation of equipment. Both the number and amplitude of temperature changes, the time interval between them and the thermal responsiveness of the equipment (or specimen) are important.

5.2 Design of tests with temperature change

Change of temperature Tests Na, Nb and Nc comprise alternate periods at a high and a low temperature with well-defined transfers from one temperature to the other. The conditioning run from the laboratory ambient temperature to the first conditioning temperature, then to the second conditioning temperature, then back to the laboratory ambient temperature is considered as one test cycle.

5.3 Test parameters

Test parameters comprise the following:

– laboratory ambient conditions (mainly temperature and humidity);

– high conditioning temperature T_{B};

– increased high conditioning temperature T_{Bi}, if applicable;

– low conditioning temperature T_{A};

– decreased low conditioning temperature T_{Ad}, if applicable;

– exposure time t_1 of the specimen to each conditioning temperature;

– transfer time t_2 or temperature change rate $\mathrm{d}T_{\mathrm{R}}$;

– number of test cycles.

As these tests are intended to validate the effects of temperature changes on the specimen, the specimen’s characteristics should always be taken into consideration (if not specified otherwise):

– thermal responsiveness of the specimen in affected areas or the core;
  • thermal conductivity;
  • specific heat capacity;

– density;

– geometry;

– mass.

The experimental determination of these characteristics is recommended, if unknown and not specified otherwise.

The test is accelerated because the number of severe changes of temperature in a given period is greater than that which will occur under field conditions.

The high and low conditioning temperatures are understood to be ambient temperatures which will be reached by most specimens with a certain time lag. It is recommended to consider the specimen’s characteristics when specifying the test. Annex A gives further information on potential consequences of improper severities of tests.

Only in exceptional cases should these temperatures be specified outside the normal storage or operating temperature range of the object under test.

NOTE If the specimen's characteristics (mass, density, geometry) prevent the specified rate of change, the temperatures can be specified outside the normal storage or operating temperatures to increase the severity of the intended test, if not specified otherwise.

5.4 Purpose and choice of the tests

Change of temperature testing is recommended in the following cases:

– evaluation of electrical performance after a specified number of rapid changes of temperature, Test Na or Test Nc;

– evaluation of the suitability of mechanical components, and of materials and combinations of materials to withstand rapid changes of temperature, Test Na or Test Nc;

– evaluation of the suitability of construction of components to withstand artificial stressing, Test Na or Test Nc;

– evaluation of electrical performance as a consequence of a change of temperature, Test Nb;

– evaluation of mechanical performance as a consequence of a change of temperature, Test Nb.

The change of temperature tests specified in the IEC 60068 series is not intended to evaluate the difference in material constants or electrical performance when operating under the conditioning temperatures T_A and T_B.

5.5 Choice of the exposure time to each conditioning temperature

The duration of the exposure should be based on the requirements stated in 7.2.3, 8.2.3 or 9.2.2, or as stated in the relevant specification, keeping in mind the following points:

a) The exposure begins as soon as the specimen is in the new environment.

b) Stabilization occurs when the temperature difference between the specimen and the test medium (ΔT_s) is within 5 K, or as stated in the test specification. The stabilization time of specimen temperature t_s is from the start of exposure until the moment when the temperature is within the specified difference. A representative point (or points) on the specimen can be used for this measurement.

c) The exposure time t_1 of the specimen to each conditioning temperature shall be longer than the stabilization time of the specimen temperature t_s. Figure 1 provides a graphical representation of the process. It is possible that this will not be appropriate for heat generating specimens.

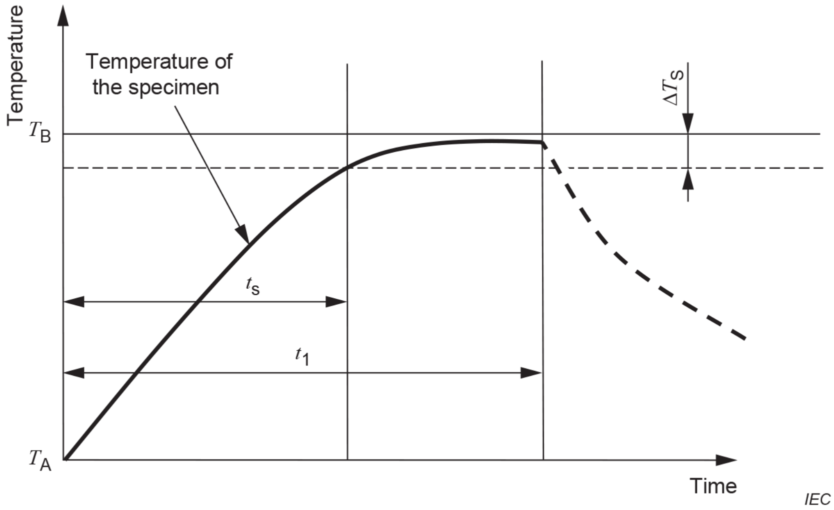


Figure 1 – Determination of the exposure time t_1 of the specimen to each conditioning temperature

5.6 Choice of the duration of the transfer time t_2

If, for example owing to the large size of the specimens, the transfer time t_2 cannot be kept within 3 min, the transfer time can be increased with a negligible influence on the test results as follows:

$$t_2 \leq 0{,}05\ t_s$$

This applies for the two-chamber test (see 7.2.1) method only. When using the one-chamber test method, period t_2 is not applicable.

5.7 Applicability limits of change of temperature tests

Inside a specimen, the temperature change rate depends on the heat conduction of its materials, the spatial distribution of its heat capacity as well as on its dimensions and surface area. A representative point (or points) on (or inside) the specimen can be used for the measurement of the temperature change rates.

NOTE 1 The rate of temperature change of specimens made of the same material and mass can vary if their surfaces differ from each other.

The change of temperature at one point on the surface of a specimen follows approximately an exponential law. Inside large specimens, such alternate exponential rises and decreases can lead to periodic and approximately sinusoidal changes of temperature with much lower amplitudes than the applied temperature swing. Annex B gives further information on the thermal responsiveness of different materials and geometries.

The mechanism of heat transfer between the test specimen and the conditioning medium in the chamber or bath should be considered. Liquid in motion leads to very high rates of change of temperature on the surface of the specimens and still air to very low rates.

NOTE 2 If more than one specimen is tested in the same test chamber, a uniform incoming airflow can be disturbed. For further information on the relation of airflow and specimen temperature, IEC 60068-3-1 can be helpful.

The two-bath method with water as a conditioning medium (Test Nc) should be restricted to specimens which are either sealed or are by their nature insensitive to water, since their performance and properties can deteriorate by immersion.

In particular cases, such as with specimens sensitive to water, a test with liquid other than water should be specified. When designing such a test, the characteristics of heat transfer of the liquid, which can differ from those of water, shall be considered.

NOTE 3 To assess the applicability of the two-bath method, evaluations from Test Q: Sealing (IEC 60068-2-17) can be helpful.

The application of Tests N is preferred as part of a sequence of tests. It is possible that some types of damage will not become apparent by the final measurements of a Test N but will appear only during subsequent tests.

An exemplary sequence of tests can be IEC 60068-2-17 Test Q: Sealing, IEC 60068-2-6 Test Fc: Vibration (sinusoidal), IEC 60068-2-30 Test Db: Damp heat, cyclic (12 h + 12 h cycle) or IEC 60068-2-67 Test Cy: Damp heat.

The change of temperature Test Nc (Two-bath method) should not be used as an alternative to Test Q (Sealing).

When specifying a change of temperature test, the properties of the objects under test which are affected by conditions of changing temperature, and their possible failure mechanisms, should be kept in mind. The initial and the final measurements should be specified accordingly.

6 Initial and final measurements

6.1 General

Tests Na, Nb and Nc all use the same initial and final measurements.

6.2 Initial measurements

The specimen shall be visually examined and electrically and mechanically checked, as required by the relevant specification.

6.3 Final measurements

The specimen shall be visually examined and electrically and mechanically checked, as required by the relevant specification.

7 Test Na: Rapid change of temperature

7.1 General description of the test

This test determines the ability of components, equipment or other articles to withstand rapid changes of ambient temperature. The exposure times adequate to accomplish this will depend upon the nature of the specimen. The specimen shall be either in the unpacked, switched-off, ready for use state, or as otherwise specified in the relevant specification. The specimen is exposed to rapid changes of temperature in air, or in a suitable inert gas, by alternating exposure to a low and a high conditioning temperature.

7.2 Testing procedure

7.2.1 Testing chamber

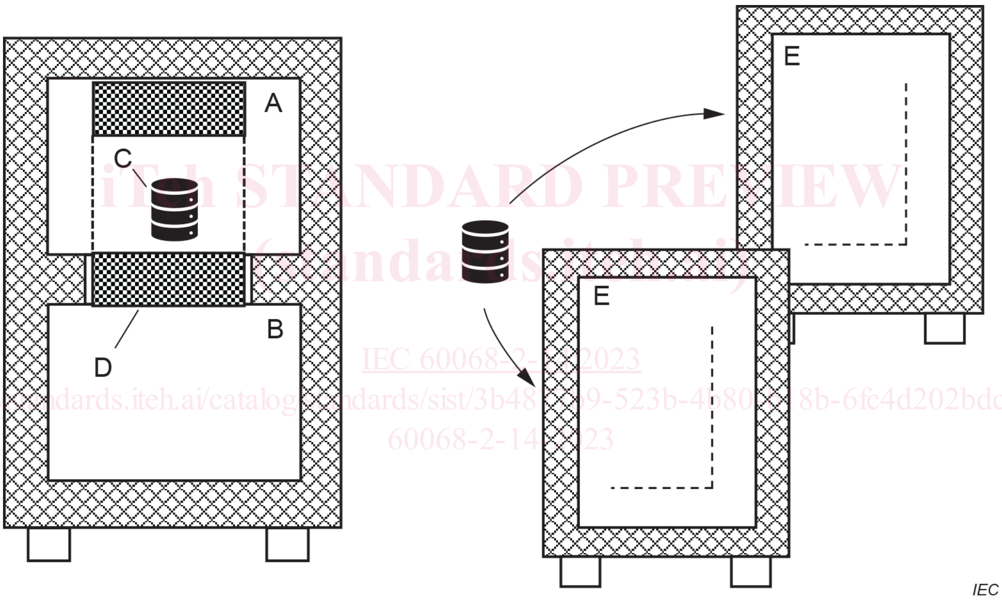
Two separate chambers (two-chamber method, see Figure 2) or one rapid temperature change rate chamber (one-chamber method, see Figure 3) can be used. If two chambers are used, one for the low temperature and one for the high temperature, the location shall be such as to allow transfer of the specimen from one chamber to the other within the specified time. Either manual or automatic transfer methods can be used.

Some two-chamber method systems are known as thermal shock test cabinets. These systems combine characteristics of two separate test chambers and are equipped with a mobile lifting cage (applies for horizontal shock test chambers as well) for the automatic transfer of the specimens from one chamber to another (see Figure 2).

Damper shock test cabinets are another embodiment of a one-chamber test system. These systems contain two conditioning and one test chamber. The test chamber is alternately exposed to conditioned air from a hot respectively cold conditioning chamber via air flaps (see Figure 3). No physical transfer is required and the transfer time t_2 is not applicable, when using this kind of test systems.

Damper shock test cabinets with a stationary test chamber, a hot chamber and a cold chamber are commonly capable of two-zone tests with hot respectively cold exposure. Some are capable of three-zone tests, including exposure to ambient air.

NOTE 1 Damper and basket-type test cabinets are often used for Test Na. Depending on the performance, two separate chambers or one rapid temperature change rate chamber are often used for Test Na as well. One rapid temperature change rate chamber is often used for Test Nb.



Key

A	hot chamber	**B**	cold chamber	**C**	specimen
D	mobile cage	**E**	stationary test space		

Figure 2 – Schematic representation of examples of thermal test cabinets and test procedure with two separate test chambers