BS EN 60068-2-53:2010

BSI Standards Publication

Environmental testing

Part 2-53: Tests and guidance: Combined climatic (temperature/humidity) and dynamic (vibration/shock) tests

National foreword

This British Standard is the UK implementation of EN 60068-2-53:2010. It is identical to IEC 60068-2-53:2010. It supersedes BS 2011-2.2Z/AFC, Z/BFC:1986, BS EN 60068-2-50:2000 and BS EN 60068-2-51:2000 which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/104, Environmental conditions, classification and testing.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 56268 6

ICS 19.040

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2010.

Amendments issued since publication

Amd. No.	Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60068-2-53

May 2010

ICS 19.040

Supersedes EN 60068-2-50:1999, EN 60068-2-51:1999

English version

Environmental testing - Part 2-53: Tests and guidance: Combined climatic (temperature/humidity) and dynamic (vibration/shock) tests

(IEC 60068-2-53:2010)

Essais d'environnement -
Partie 2-53: Essais et guide: Essais combinés climatiques (température/humidité) et dynamiques (vibrations/chocs)
(CEI 60068-2-53:2010)

Umgebungseinflüsse -
Teil 2-53: Prüfverfahren - Prüfungen und Leitfaden - Kombinierte klimatische (Temperatur/Feuchte) und dynamische (Schwingung/Schock) Prüfungen
(IEC 60068-2-53:2010)

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Europäisches Komitee für Elektrotechnische Normung

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Ref. No. EN 60068-2-53:2010 E

Foreword

The text of document 104/499/FDIS, future edition 2 of IEC 60068-2-53, prepared by IEC TC 104, Environmental conditions, classification and methods of test, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60068-2-53 on 2010-05-01.

This European Standard supersedes EN 60068-2-50:1999 and EN 60068-2-51:1999.

The main changes with respect to 60068-2-50:1999 and EN 60068-2-51:1999 is to update and group tests. In this way it allows for the possibility to use different kinds of vibration excitation – sine, random or mixed mode – or shocks, with different tests for climatic conditions – cold, dry heat, change of temperature or constant and cyclic damp heat.

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

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-02-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-05-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60068-2-53:2010 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60068-2-33	NOTE	Harmonized as EN 60068-2-33.
IEC 60068-2-47	NOTE	Harmonized as EN 60068-2-47.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60068-1	-	Environmental testing - Part 1: General and guidance	EN 60068-1	-
IEC 60068-2-1	-	Environmental testing - Part 2-1: Tests - Test A: Cold	EN 60068-2-1	-
IEC 60068-2-2	-	Environmental testing - Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	-
IEC 60068-2-6	-	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	-
IEC 60068-2-14	-	Environmental testing - Part 2-14: Tests - Test N: Change of temperature	EN 60068-2-14	-
IEC 60068-2-27	-	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	-
IEC 60068-2-30	-	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	EN 60068-2-30	-
IEC 60068-2-64	-	Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance	EN 60068-2-64	-
IEC 60068-2-78	-	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state	EN 60068-2-78	-
IEC 60068-2-80	-	Environmental testing - Part 2-80: Tests - Test Fi: Vibration - Mixed mode	EN 60068-2-80	-

CONTENTS

INTRODUCTION

Equipment and components are required to function without significant reduction in performance when subjected to different environmental parameters.

The type and severity of the environmental parameters depend on the operational, transport and storage environments to which the equipment and components are subjected. The environmental effects on the performance of equipments in the tropics and subtropics are totally different from those in arctic regions. Individual parameters cause a variety of different and overlapping effects on the equipment and components.

The manufacturer attempts to ensure, and the user expects, that equipment and components will survive the environments to which they will be subjected throughout their useful life. This expectation can be assessed by exposure of the specimen to a range of simulated environmental parameters controlled in the laboratory. The severity of the environmental parameters is often increased to obtain meaningful results in a relatively short period of time. This allows assessment of the likely effects of applied environmental conditions.

The combination of temperature, humidity and vibration occurs especially in the domains of automotive, rail and aerospace environments.

ENVIRONMENTAL TESTING –

Part 2-53: Tests and guidance – Combined climatic (temperature/humidity) and dynamic (vibration/shock) tests

1 Scope

This part of IEC 60068 provides a description of test methods and guidance for testing equipment or components under combined climatic and dynamic conditions.

The purpose of combined testing is to investigate to what extent the equipment or components are affected by combined climatic and dynamic tests.

The method of combined tests detects electrical, mechanical or other physical variations.

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.

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

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*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14, *Environmental testing – Part 2-14: Test – Test N: Change of temperature*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-64, *Environmental testing – Part 2-64: Tests – Test Fh: Vibration, broadband random (digital control) and guidance*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60068-2-80, *Environmental testing – Part 2-80: Tests – Test Fi: Vibration – Mixed mode*

3 Testing

3.1 General

All parameters such as temperatures, cold, dry heat, temperature change, type of vibration, exposure time to temperature, exposure time to vibration, number of shocks, repetition time of

shocks, axis of shock or vibration, state of operation and so on, shall be selected from the relevant IEC 60068-2 standards or relevant specification.

The combinations of environmental conditions should be selected to ensure that electrical and mechanical performances of the specimen are satisfactory under storage, transportation and operational conditions. Certain combinations of possible tests shown in Table 1 may not be practicable.

Examples of these include the following:

– full sweep of sinusoidal vibration spectrum not completed during change of temperature or temperature cycling;
– temperature stabilization of dynamic non linear systems, e.g. anti vibration mounts during vibration with change of temperature or temperature cycling;
– full cycle of mixed mode vibration during change of temperature or temperature cycling.

Table 1 – Allowable combinations of IEC standards

Climatic tests	Dynamic tests			
	Shock	Vibration (sinusoidal)	Vibration (broad band random)	Vibration (mixed mode)
	IEC 60068-2-27	IEC 60068-2-6	IEC 60068-2-64	IEC 60068-2-80
Cold IEC 60068-2-1	X	X	X	X
Dry heat IEC 60068-2-2	X	X	X	X
Change of temperature IEC 60068-2-14	X	X	X	X
Damp heat, cyclic IEC 60068-2-30	X	X	X	X
Damp heat, constant IEC 60068-2-78	X	X	X	X

Specimens may be repositioned for shock or vibration along another axis at standard climatic conditions according to IEC 60068-1, as required by the relevant specification. The dynamic test shall be continued when the required test temperature and humidity has been reached.

3.2 Temperature information

If cold or dry heat testing is required, the exposure time shall not commence until all parts of the specimen have reached a temperature within at least 3 K of the working space temperature. For heat-dissipating specimens, the period of exposure shall not begin until the temperature of the specimens changes not more than 1 K within 1 h at the stabilized working space temperature. The last hour of the temperature-soaking time shall be considered to be the first hour of the exposure period.

If a damp heat constant testing is required, the exposure time shall not commence until all parts of the specimen have reached a temperature within at least 3 K of the temperature, and a relative humidity within 3 % of the humidity, within the working space of the test chamber. For heat-dissipating specimens, the period of exposure shall not begin until the temperature of the specimens changes not more than 1 K within 1 h at the stabilized working space temperature. The last hour of the temperature-soaking time shall be considered to be the first hour of the exposure period.

If slow temperature change test or damp heat cyclic test is performed, the required exposure time starts with the beginning of temperature change.

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

3.3 Dynamic test information

The relevant specification shall contain dynamic test information. The dynamic test information includes following details (see also Clause 5):

a) identification of dynamic test (such as sinusoidal, random, mixed mode vibration or impact);
b) severities of dynamic stress;
c) axis and directions of dynamic stress;
d) duration and timing of dynamic stress (see Annex A);
e) IEC 60068-2-47 shall be referred to concerning mounting of specimen;
f) other details specified in the reference standards.

3.4 Initial measurement and functional performance test

The specimen shall be submitted to the visual, dimensional, functional and any other checks prescribed by the relevant specification.

3.5 Operating condition of specimen

In the case of electrically-operated specimens, the times at which the power supply shall be powered on or off 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.

3.6 Mechanical conditioning of specimen

The mechanical conditioning of the specimen per cycle shall preferably be performed in the last hour of the hot or cold phase, i.e. prior to the changeover to the following limit temperature, or shall be performed in any other combination which can be defined in the relevant specification. If the specimen is operated by power supply, this shall be connected for the duration of the mechanical conditioning.

4 Final measurements

The specimen shall be submitted to the visual, dimensional and functional checks prescribed by the relevant specification.

The relevant specification shall provide the criteria upon which the acceptance or rejection of the specimen is to be based.

5 Information to be given in the relevant specification

The relevant specification shall contain the following details as far as they are applicable:

a) exposure time to temperature;
b) test chamber temperature change rate;

c) test temperature;
d) number of temperature cycles;
e) combined test schedule;
f) vibration severity;
g) number of cycles, by damp heat, cyclic;
h) shock severity;
i) axis and directions of shock and/or vibration;
j) state of operation;
k) number of specimens,
l) humidity if relevant for combined test;
m) preconditioning;
n) type and scope of initial measurement;
o) period of operation;
p) type and scope of intermediate measurement;
q) recovery;
r) type and scope of final measurement;
s) criteria for evaluation;
t) type and scope of test report.

6 Information to be given in the test report

When this test included in the relevant specification, the following details shall be given where applicable:

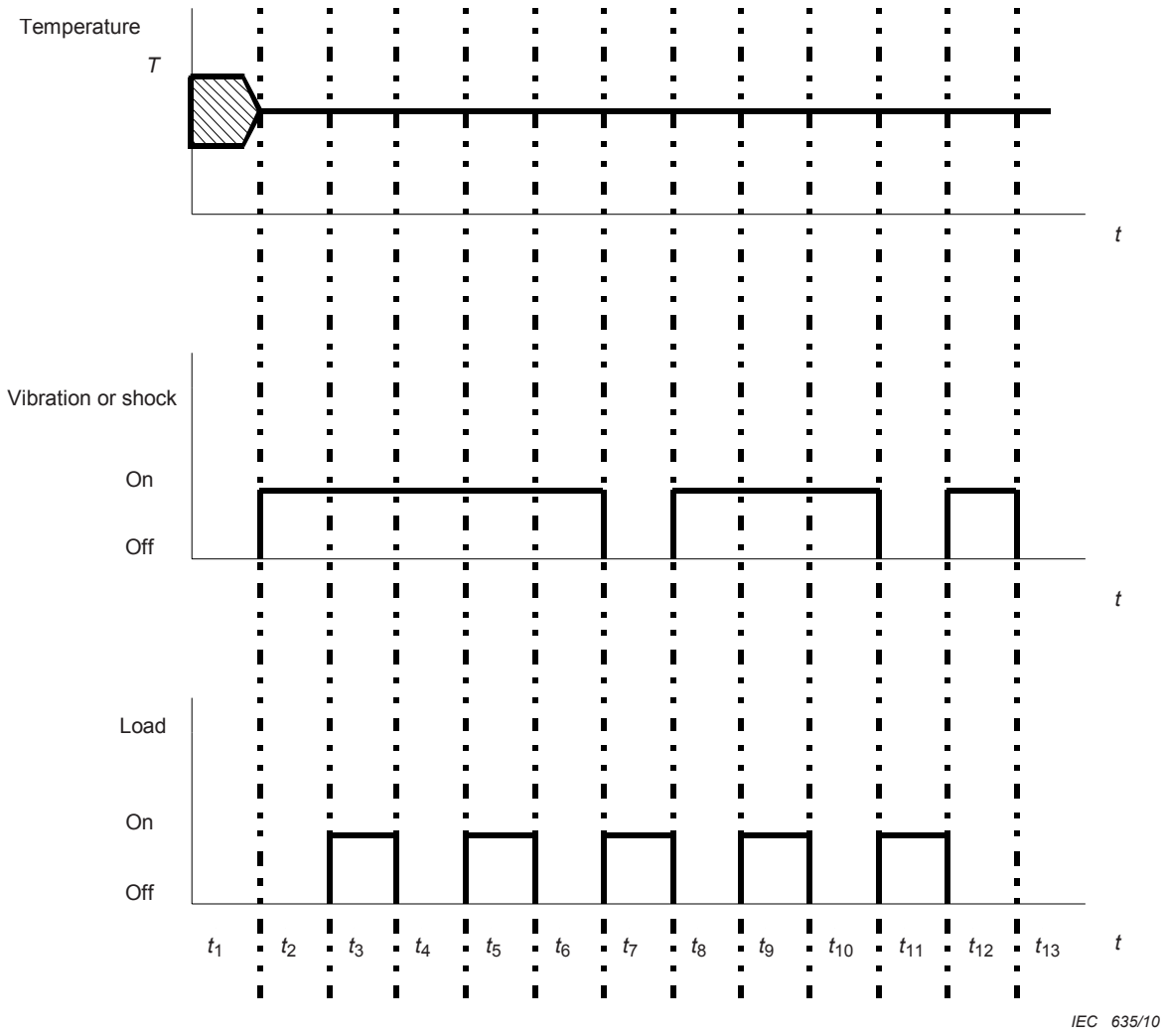
a)	Customer	(name and address)
b)	Test laboratory	(name and address and details of accreditation – if any)
c)	Test dates	(dates when test was run)
d)	Type of test	(kind of vibration or shock, cold or dry heat, slow temperature change, damp heat, cyclic or constant)
e)	Required values	(temperature, humidity, acceleration, frequency range, etc.)
f)	Purpose of test	(development, qualification, etc.)
g)	Test standard, edition	(IEC 60068-2-53, edition used)
h)	Relevant laboratory test procedure	(code and issue)
i)	Test specimen description	(drawing, photo, quantity build status, etc.)
j)	Test chamber and vibration system identity	(manufacturer, model number, unique id, etc.)
k)	Performance of test apparatus	(set point temperature control, set point acceleration control air flow, etc.)
l)	Air velocity and direction	(air velocity and direction of incident air to the specimen)
m)	Uncertainties of measurement system	(uncertainties data, including temperature stability of transducer sensitivities)
n)	Calibration data	(last and next due date)
o)	Initial, intermediate and final measurements	(initial, intermediate and final measurements)
p)	Required severities	(from relevant specification)

q)	Test severities	(measuring points, data, etc.)
r)	Performance of test specimens	(results of functional tests etc.)
s)	Observations during testing and actions taken	(any pertinent observations)
t)	Summary of test	(test summary)
u)	Distribution	(distribution list)

Annex A
(informative)

Examples of test sequences

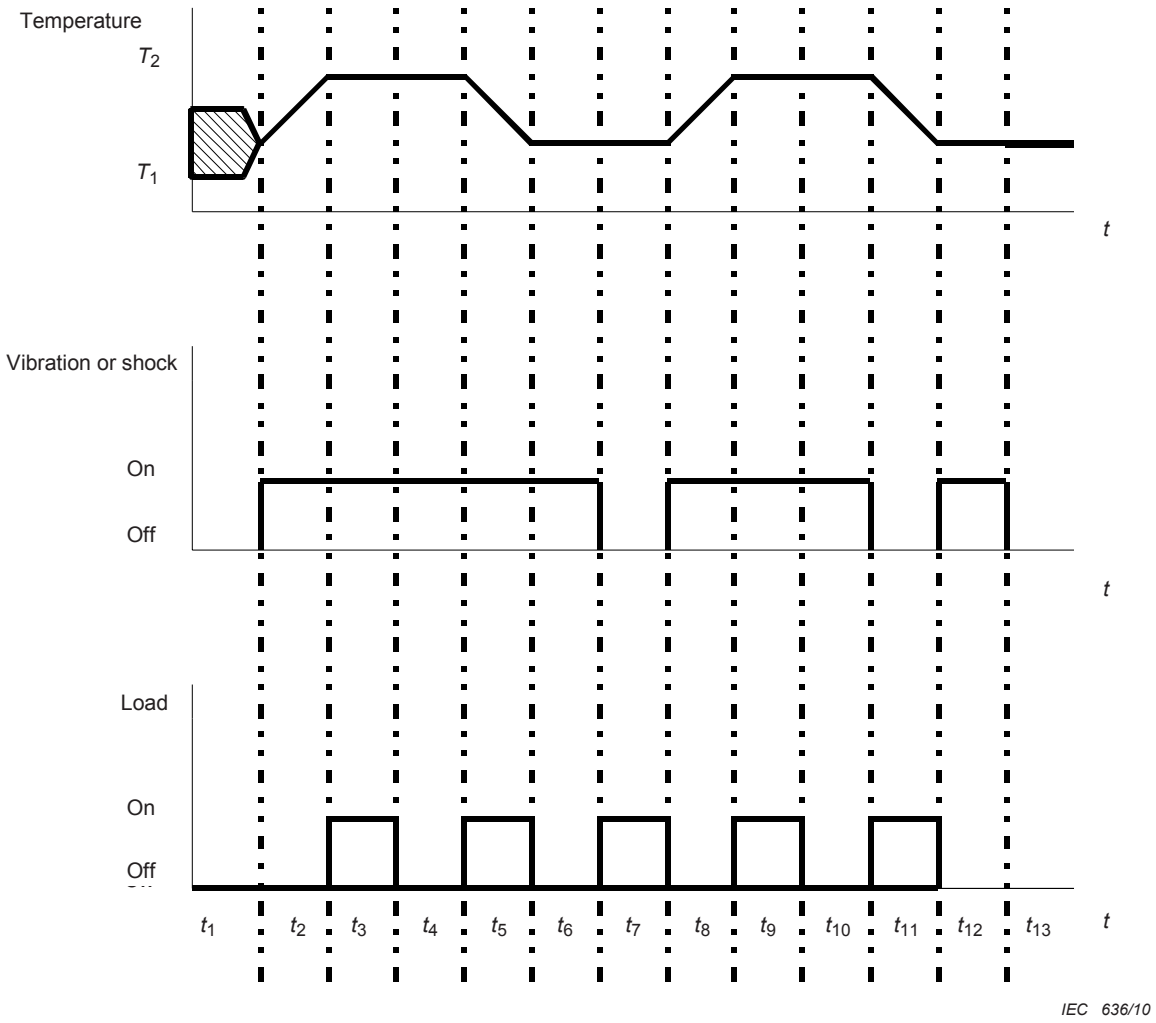
Figures A.1 to A.4 represent examples of a test sequence combination of climatic conditions (temperature and/or humidity), dynamic conditions (vibration or shock) and electric loads conditions.



Key

T	required temperature
t_1	temperature non stabilized
t_2 to t_{13}	temperature stabilized
t_2-t_6; t_8-t_{10}; t_{12}	any kind of vibration or shock
t_3; t_5; t_7; t_9; t_{11}	with electrical load and/or functional check

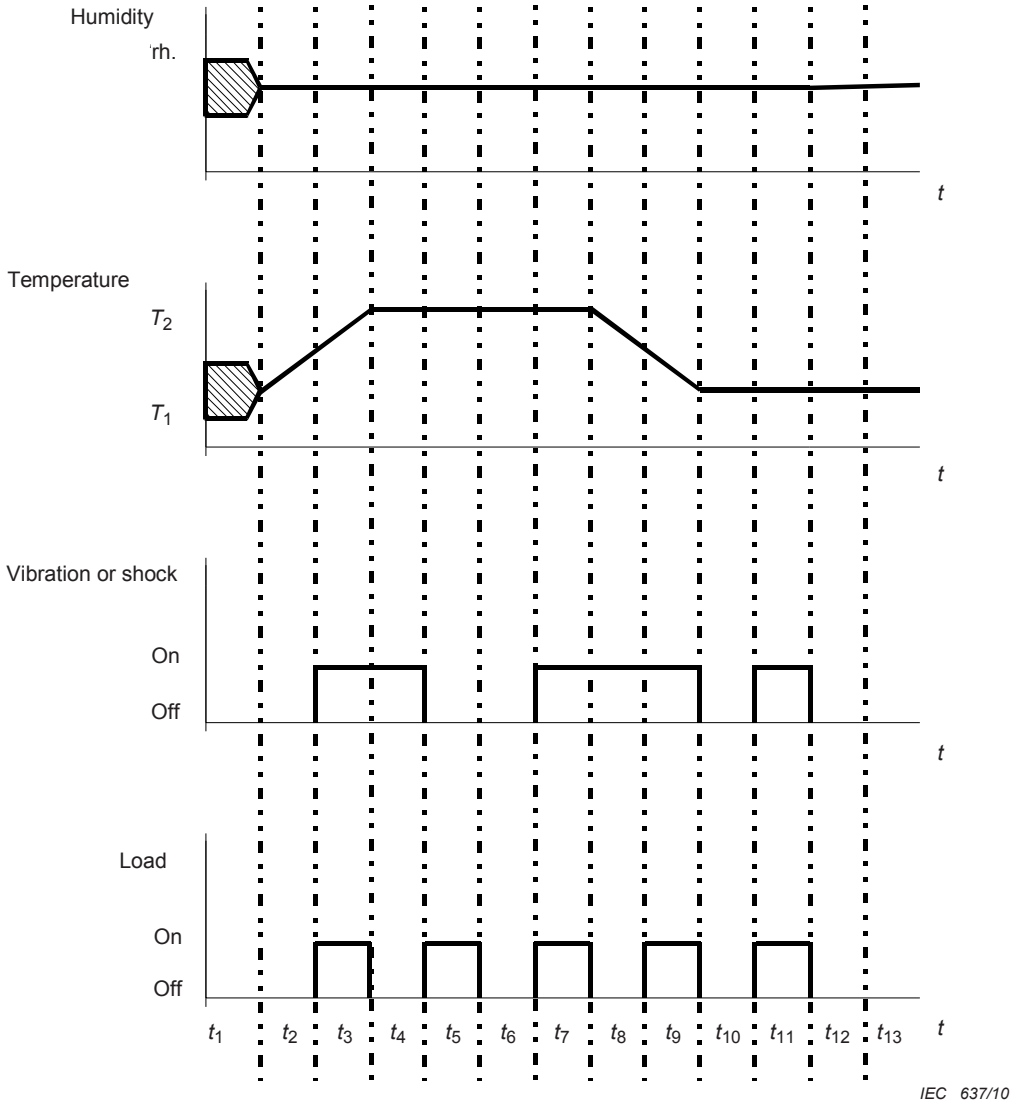
Figure A.1 – Example of test sequence with cold or dry heat testing



Key

T_1	required lower temperature
T_2	required upper temperature
t_1	temperature non stabilized
t_2	temperature change from T_1 to T_2
t_3 and t_4	upper temperature constant
t_5	temperature change from T_2 to T_1
t_6 and t_7	lower temperature constant
t_8	temperature change from T_1 to T_2
t_9 and t_{10}	upper temperature constant
t_{11}	temperature change from T_2 to
t_{12} and t_{13}	lower temperature constant
t_2 to t_6; t_8 to t_{10}; t_{12}	any kind of vibration or shock
t_3; t_5; t_7; t_9; t_{11}	with electrical load and/or functional check

Figure A.2 – Example of test sequence with slow temperature

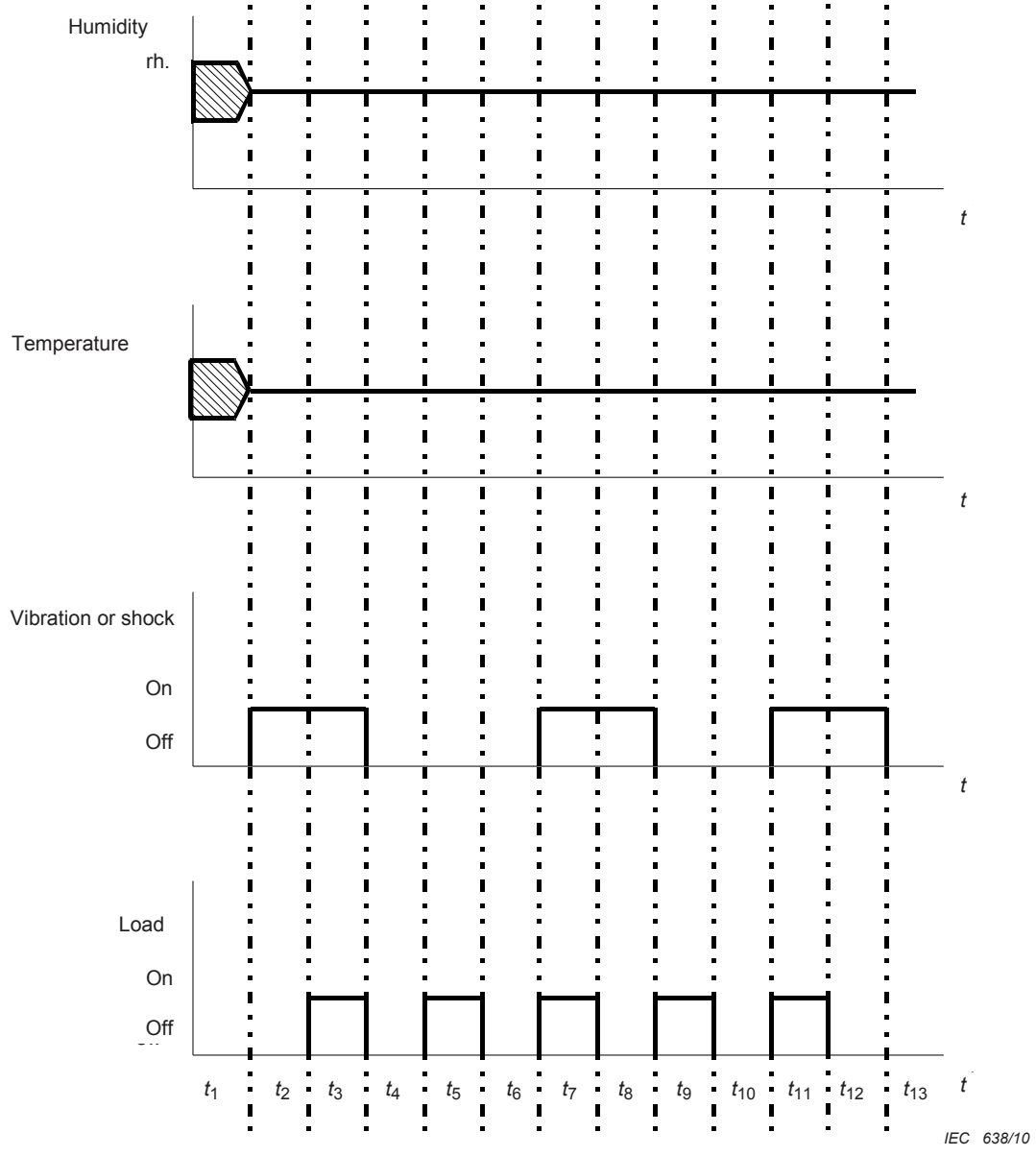


Key

rh	required relative humidity
T_1	required lower temperature
T_2	required upper temperature
t_1	temperature and humidity non stabilized
t_2 and t_3	temperature change from T_1 to T_2
t_4 to t_7	upper temperature constant
t_8 and t_9	temperature change from T_2 to T_1
t_{10} to t_{13}	lower temperature constant
t_3 and t_4; t_7 to t_9; t_{11}	any kind of vibration or shock
t_3; t_5; t_7; t_9; t_{11}	with electrical load and/or functional check

NOTE Humidity will not stay constant while temperature is changing. It should be restabilized within 3 % before going to the next step

Figure A.3 – Example of test sequence with damp heat, cyclic



Key

rh	required relative humidity
T	required temperature
t_1	temperature and humidity non stabilized
t_2 to t_3; t_7 to t_8; t_{11} to t_{12}	any kind of vibration or shock
t_3; t_5; t_7; t_9; t_{11}	with electrical load and/or functional check

Figure A.4 – Example of test sequence with damp heat, constant

Annex B
(informative)

Guidance on combined climatic and dynamic testing

B.1 General

This annex furnishes fundamental comments for applying combined tests of temperature and/or humidity with vibration or shock, based on different parts within the IEC 60068 series.

For the purposes of combined testing, IEC 60068-1, Environmental testing – Part 1: General and guidance, shall be used together with the relevant preferred values described in IEC 60068-2.

B.2 Consideration of test procedure

For combined testing, it may be necessary to test with high air circulation for the following reasons:

a) dissipation of heat from the shaker;

b) air circulation about the specimen may be reduced by the presence of the shaker.

B.3 Environmental conditions

In the following, the effects of low and high temperature and vibration on materials are described.

a) Both low and high temperature can change the qualities of materials. In addition, the risk of damage is increased by vibration. Equipment with many different materials or with ropy, elastic materials, can be very sensitive during a combined test of temperature, humidity and vibration.

b) Under extreme temperatures the characteristic frequency may be shifted so that the introduced vibration will be enhanced. At low temperature the effect is significant for a vibration absorber consisting of rubber elastic materials.

B.4 Testing equipment

The combined tests with temperature, humidity and vibration can be performed with different equipment. Typical is an electro-dynamic shaker with a climatic test chamber on top (see Figure B.1) or an electro-dynamic shaker inside a climatic test chamber.

If an electro-dynamic shaker with a climatic test chamber above is used, the table of the shaker shall be thermally isolated from the body of the shaker and the climatic test chamber. Parts of the thermal isolation are not allowed to assign impermissible vibration. Mechanical coupling between the shaker and the test chamber shall be prohibited because the test chamber could be damaged.

B.5 Measurement of environmental conditions

B.5.1 Measurement of temperature

The equipment to measure the temperature can be stressed by high values of acceleration. Therefore, the temperature sensor shall be durably fixed. Also it shall not change the dynamic behaviour of the specimen.

B.5.2 Measurement of acceleration

The cable and the accelerometer shall withstand the requirements of temperature and humidity. The accelerometer shall be calibrated for all necessary temperatures because the sensitivity can vary with the temperature. If the sensitivity is not uniform, this shall be considered in the calculation of the vibration amplitude tolerance according to the applicable vibration or shock test standard. If the sensitivity of the accelerometer varies with temperature it is advisable that a suitable compensation mechanism should be used. Otherwise, it is possible that the tolerance for acceleration stated in the applicable vibration test standard is violated. An according note in the test report shall be made.

The fixing material for the accelerometer shall retain the physical property throughout all necessary temperatures and humidity.

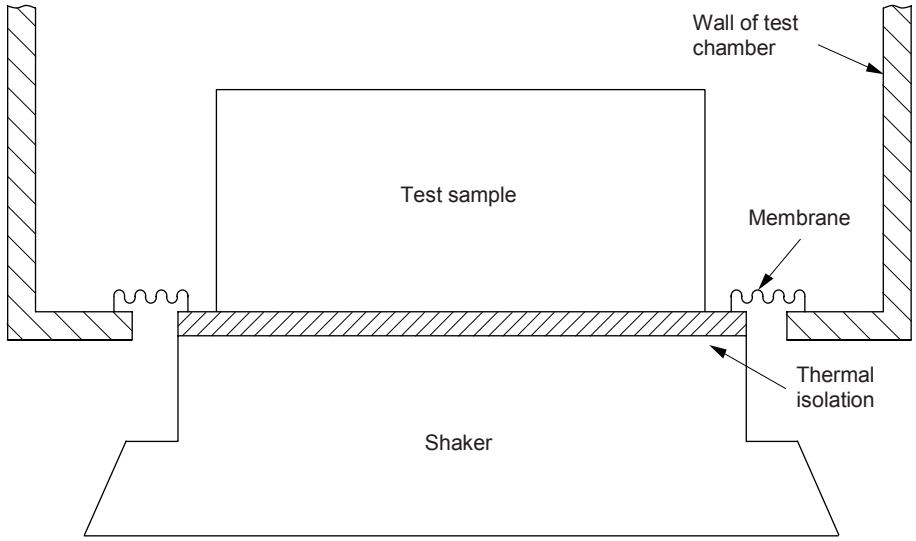


Figure B.1 – Example for a typically test set-up

Bibliography

IEC 60068-2-33, *Environmental testing – Part 2-33: Tests – Guidance on change of temperature tests*

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

ISO 16750 (all parts), *Road vehicles – Environmental conditions and testing for electrical and electronic equipment*

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