IEC 60068-2-57

Edition 3.0 2013-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental testing –
Part 2-57: Tests – Test Ff: Vibration – Time-history and sine-beat method

Essais d'environnement –
Partie 2-57: Essais – Essai Ff: Vibrations – Méthode par accélérogrammes et sinusoïdes modulées

IEC 60068-2-57:2013

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX X

ICS 19.040 ISBN 978-2-83220-745-1

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ENVIRONMENTAL TESTING –

Part 2-57: Tests – Test Ff: Vibration – Time-history and sine-beat method

FOREWORD

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International Standard IEC 60068-2-57 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This third edition cancels and replaces the second edition, published in 1999. It also replaces IEC 60068-2-59:1990, which will be withdrawn.

This edition includes only minor technical changes with respect to the previous edition:

– editorially combines IEC 60068-2-57 and IEC 60068-2-59;
– the title has been modified to include a sine beat method.

The text of this standard is based on the following documents:

FDIS	Report on voting
104/595/FDIS	104/612/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

This standard is to be used in conjunction with IEC 60068-1.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

INTRODUCTION

This part of IEC 60068 details methods for testing components, equipment and other electrotechnical products (hereinafter referred to as “specimens”) which in service can be subjected to random or oscillating type dynamic forces of short duration, typical examples of which are the stresses induced in equipment as a result of earthquakes, explosions and certain phases of transportation, or by transient, short time vibration in machinery.

The characteristics of these forces and the damping of the specimen may be such that the vibration response of the specimen will not reach a steady-state condition.

The time-history test consists, after any preliminary vibration response investigation with sinusoidal or random vibration, in subjecting the specimen to a vibration (acceleration, velocity or displacement) the time history being specified by a response spectrum with characteristics simulating the effects of the dynamic forces.

A time history may be developed or obtained from

– a natural event (natural time history),
– a random sample } artificial time history.
– a synthesized signal }

In general, to adapt to the required testing severity, some modification is necessary.

The use of a time history allows a single test wave to envelop a broadband response spectrum.

It is possible for all the modes of the structure in the excitation axis (or axes) to be excited at the same time and consequently the stresses derived from the combined effects of the coupled modes are generally taken into account.

In the sine beat test, the specimen is excited at fixed frequencies with a preset number of sine beats (see Figure 1). These fixed test frequencies are predetermined test frequencies, or critical frequencies identified by means of a sinusoidal vibration test (IEC 60068-2-6), or both. Pauses are provided between the individual sine beats in order to allow decay of the free response of the specimen.

In Clause 12 specification writers will find a list of details to be considered for inclusion in specifications and, in Annex A, guidance giving necessary extra information.

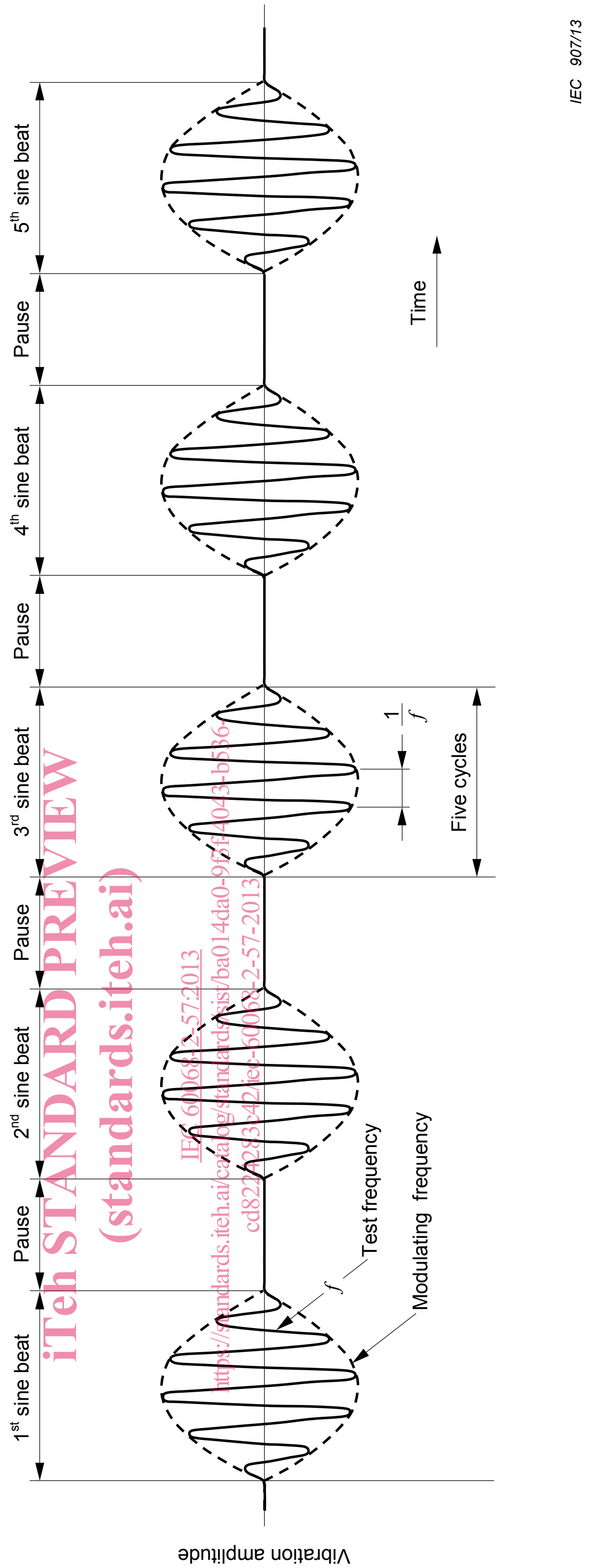


Figure 1 – Sequence of five sine beats with five cycles

ENVIRONMENTAL TESTING –

Part 2-57: Tests – Test Ff: Vibration – Time-history and sine-beat method

1 Scope

This part of IEC 60068 provides a standard procedure for determining, by the time-history and sine-beat methods, the ability of a specimen to withstand specified severities of transient vibration.

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.

IEC 60068 (all parts), *Environmental testing*

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

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-47:2005, *Environmental testing – Part 2-47: Tests – Mounting of specimens for vibration, impact and similar dynamic tests*

IEC 60068-2-64:2008, *Environmental testing – Part 2-64: Tests –Vibration, broadband random and guidance*

IEC 60068-3-3:1991, *Environmental testing – Part 3: Guidance – Seismic test methods for equipments*

IEC 60068-3-8, *Environmental testing – Part 3-8: Supporting documentation and guidance – Selecting amongst vibration tests*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE Some of the following terms can be found in ISO 2041, IEC 60068-1 or in IEC 60068-2-6. Where, for the convenience of the reader, a definition from one of those sources is included here, it is indicated.

3.1
critical frequency
frequency at which

– malfunctioning and/or deterioration of performance of the specimen which are dependent on vibration are exhibited, and/or
– mechanical resonances and/or other response effects occur, for example chatter

[SOURCE: IEC 60068-2-6:2007, definition 3.9]

3.2
crossover frequency
frequency at which the characteristic of a vibration changes from one relationship to another

Note 1 to entry: For example, a crossover frequency may be that frequency at which the test vibration amplitude changes from a constant displacement value versus frequency to a constant acceleration value versus frequency.

[SOURCE: ISO 2041:2007, definition 2.118]

3.3
damping
progressive reduction of the amplitude with time due to the dissipation of energy in a system

Note 1 to entry: In practice, damping depends on many parameters, such as the structural system, mode of vibration, strain, applied forces, velocity, materials, joint slippage, etc.

[SOURCE: IEC 60068-2-6:2007, definition 3.8, modified – original text reads "generic term ascribed to the numerous energy dissipation mechanisms in a system"; Note remains same]

3.4
viscous damping
damping that occurs when an element or a part of a vibration system is resisted by a force the magnitude of which is proportional to the velocity of the element and the direction of which is opposite to the direction of the velocity

3.5
critical damping
C_c
minimum viscous damping that will allow a displaced system to return to its initial position without oscillation

3.6
damping ratio
ratio of actual viscous damping to critical damping in a system with viscous damping

Note 1 to entry: The damping ratio (*DR*) can be calculated using the formula $DR = C/C_c$ where C is actual viscous damping value and C_c is the critical damping.

Note 2 to entry: This parameter is normally expressed as a percentage value.

3.7
signal tolerance

signal tolerance $T = \left(\frac{NF}{F} - 1\right) \times 100$ (per cent)

where

NF is the r.m.s value of the unfiltered signal;

F is the r.m.s value of the filtered signal.

Note 1 to entry: This parameter applies to whichever signal, i.e. acceleration, velocity or displacement, is being used to control the test (see A.2.2 of IEC 60068-2-6:2007)

3.8
fixing point
part of the specimen in contact with the fixture or vibration table at a point where the specimen is normally fastened in service

Note 1 to entry: If a part of the real mounting structure is used as the fixture, the fixing points are taken as those of the mounting structure and not of the specimen.

[SOURCE: IEC 60068-2-6:2007, definition 3.1, modified – omission of the second NOTE]

3.9
standard acceleration
g_n
standard acceleration due to the earth's gravity, which itself varies with altitude and geographical latitude

Note 1 to entry: For the purposes of this standard, the value of g_n is rounded up to the nearest whole number, that is 10 m/s².

3.10
high stress cycles
response cycles giving rise to values of stress which may cause degradation, deformation or low cycle fatigue in the specimen

Note 1 to entry: Stresses in the specimen are normally not measured or controlled. High stress is used here as a circumscription for high excitation, see A.1.4.

3.11
measuring points
specific points at which data are gathered for conducting the test

Note 1 to entry: These points are of two main types, as defined below

Note 2 to entry: Measurements may be made at points within the specimen in order to assess its behaviour; these are not considered as measuring points in the sense of this standard.

[SOURCE: IEC 60068-2-6:2007, definition 3.2]

3.11.1
check point
point located on the fixture, the real mounting structure, on the vibration table or on the specimen as close as possible to one of its fixing points and in any case rigidly connected to it

Note 1 to entry: A number of check points are used as a means of ensuring that the test requirements are satisfied.

Note 2 to entry: If four or fewer fixing points exist, each is used as a check point. If more than four fixing points exist, four representative fixing points will be defined in the relevant specification to be used as check points.

Note 3 to entry: In special cases, for example for large or complex specimens, the check points will be prescribed by the relevant specification if not close to the fixing points.

Note 4 to entry: Where a large number of small specimens are mounted on one fixture, or in the case of a small specimen where there are a number of fixing points, a single check point (that is the reference point) may be selected for the derivation of the control signal. This signal is then related to the fixture rather than to the fixing points of the specimen(s). This procedure is only valid when the lowest resonance frequency of the loaded fixture is well above the upper frequency of the test.

3.11.2
reference point
point, chosen from the check points, whose signal is used to control the test, so that the requirements of this standard are satisfied

[SOURCE: IEC 60068-2-6:2007, definition 3.2.2]

3.12
modulating frequency
frequency with which the test frequency is modulated

Note 1 to entry: See A.2.2 and Figure 1.

3.13
natural time history
recording, as a function of time, of the acceleration, velocity or displacement, etc., resulting from a given event

3.14
oscillator
single degree of freedom system intended to produce or be capable of maintaining mechanical oscillations

3.15
pause
interval between two consecutive time histories or sine beats

Note 1 to entry: A pause should be such as to result in no significant superposition of the response motion of the specimen.

For sine beats, this is:

$$T > \frac{1}{f} \cdot \frac{100}{C_{\mathrm{c}}}$$

where

T is the duration (s);

f is the sine beat test frequency (Hz);

C_{c} is the critical damping at the test frequency (in per cent).

3.16
preferred testing axes
three orthogonal axes which correspond to the most vulnerable axes of the specimen

3.17
required response spectrum
response spectrum specified by the user (customer)

3.18
response spectrum
plot of the maximum response to a defined input motion of a family of single-degree-of-freedom bodies as a function of their natural frequencies and at a specified damping ratio

3.19
sine beat
continuous sinusoidal wave of one frequency which is modulated by a sinusoidal wave of a lower frequency

Note 1 to entry: The duration of one sine beat is half the period of the modulating frequency (see Figure 2).

Note 2 to entry: See A.2.2.1 for a mathematical explanation of the sine-beat signal.

3.20
strong part of the time history
part of time history from the time when the plot first reaches 25 % of the maximum value to the time when it falls for the last time to the 25 % level (see Figure 3)

3.21
sweep cycle
traverse of the specified frequency range once in each direction, for example 1 Hz to 35 Hz to 1 Hz

[SOURCE: IEC 60068-2-6:2007, definition 3.4, modified – values changed, were "10 Hz to 150 Hz to 10 Hz"]

3.22
synthesized time history
artificially generated time history such that its response spectrum envelops the required response spectrum

3.23
test frequency
frequency at which the specimen is to be excited with sine beats during a test

Note 1 to entry: A test frequency is one of two types which are defined below.

3.23.1
predetermined test frequency
frequency prescribed by the relevant specification.

3.23.2
investigated test frequency
frequency obtained by a vibration response investigation

3.24
test level
largest peak value within a test wave

Note 1 to entry: This definition is not applicable to time-history testing.

Note 2 to entry: For the sine beat method, this is equal to or a negligibly smaller value than the peak value of the modulating half-wave for sine beats.

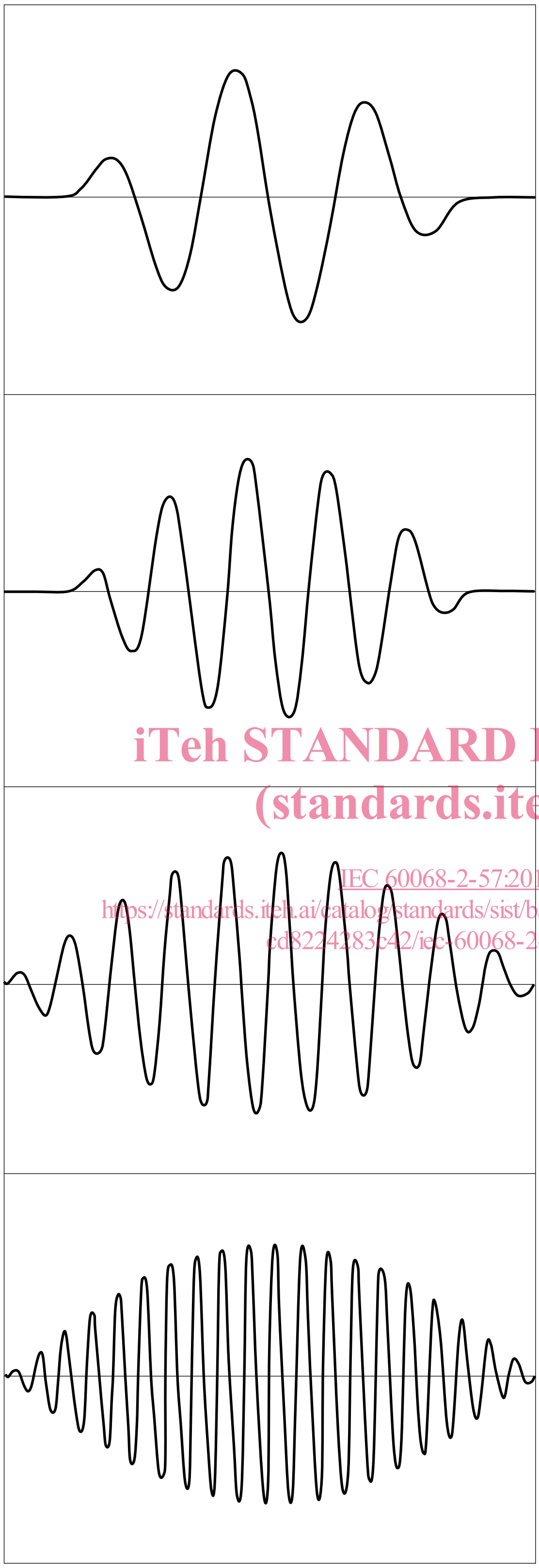
3.25
test response spectrum
response spectrum derived from the real motion of the vibration table either analytically or by using spectrum analysis equipment

3.26
time history
recording, as a function of time, of acceleration, velocity or displacement

Note 1 to entry: A definition of a mathematical term “time-history” is given in ISO 2041 and relates to the magnitude of a quantity expressed as a function of time.

3.27
zero period acceleration
high frequency asymptotic value of acceleration of the response spectrum

Note 1 to entry: The zero period acceleration is of practical significance as it represents the largest peak value of acceleration, for example in a time history. This is not to be confused with the peak value of acceleration in the response spectrum. For an example see Figure 4.



a) Sine beat of 3 cycles

b) Sine beat of 5 cycles

c) Sine beat of 10 cycles

d) Sine beat of 20 cycles

IEC 908/13

Figure 2 – Number of cycles per sine beat