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**Environmental testing—
Electrotechnical products—
Time-history vibration test method**

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from the Reliability Center for Electronic Components of Japan (RCJ)/ the Japanese Standards Association (JSA), with a draft of Industrial Standard based on the provision of Clause 1, Article 12 of the Industrial Standardization Law.

This Standard has been made based on **IEC 60068-2-57 : 1999** *Environmental testing—Part 2-57 : Tests—Test Ff : Vibration—Time-history method* for the purposes of making easy to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of International Standard which is based on Japanese Industrial Standard.

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Environmental testing— Electrotechnical products— Time-history vibration test method

Introduction This Japanese Industrial Standard has been prepared based on the second edition of **IEC 60068-2-57** *Environmental testing—Part 2-57 : Tests—Test Ff : Vibration—Time-history method* published in 1999 without modifying the technical contents.

“Informations” underlined with dots in this Standard are the matters not included in the original International Standard.

This Standard details a method for testing components, equipment and other electrotechnical products (hereafter referred to as “specimens”) which in service can be subjected to short-duration random-type dynamic forces of which typical examples are the stresses induced in equipment as a result of earthquakes, explosions and during transport and operation of different kinds of vehicles.

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 test consists, after any preliminary vibration response investigation with sinusoidal or random vibration has been performed, of subjecting the specimen to a vibration time-history 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, or
- a synthesized signal. } artificial time-history

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

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 specimen 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.

Information : Coupled modes are defined in **JIS B 0153 : 1985** as “modes of vibration that are not independent but which influence one another because of energy transfer from one mode to another”.

Procedures are described for conducting the test and for the measurement of the vibration at given points. The requirements for the vibration motion and for the choice of severities, that is frequency range, required response spectrum, number of high-peaks of the response and number and duration of time-histories, are also detailed.

Specification writers will find in clause 13 a list of details to be considered for inclusion in specifications, in annex A, on the guidance, and in annex B, on recommended test frequency ranges.

It is emphasized that vibration testing always demands a certain degree of engineering judgement and both supplier and purchaser should be fully aware of this fact. The writer of the relevant specification is expected to select the testing procedure and the values of severity appropriate to the specimen and its use.

1 Scope and object This Standard aims to provide a standard procedure for determining, by the time-history method, the ability of a specimen to withstand specified severities of transient vibration.

Remarks : The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and JIS are IDT (identical), MOD (modified), and NEQ (not equivalent) according to ISO/IEC Guide 21.

IEC 60068-2-57 : 1999 *Environmental testing—Part 2-57 : Tests—Test Ff : Vibration—Time-history method* (IDT)

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. If the indication of the year of coming into effect is given to these referred standards, only the edition of indicated year constitutes the provision of this Standard but the revision and amendment made thereafter are not applied.

JIS C 0010 : 1993 *Environmental testing Part 1 : General and guidance*

Remarks : IEC 60068-1 : 1998 *Environmental testing—Part 1 : General and guidance* is identical with the said standard.

JIS C 0036 : 1997 *Environmental testing Part 2 : Test methods—Test Fh : Vibration, broad-band random (digital control) and guidance*

Remarks : IEC 60068-2-64 : 1993 *Environmental testing—Part 2 : Test methods—Test Fh : Vibration, broad-band random (digital control) and guidance* is identical with the said standard.

JIS C 0040 : 1999 *Environmental testing Part 2 : Tests—Test Fc : Vibration (sinusoidal)*

Remarks : IEC 60068-2-6 : 1995 *Environmental testing—Part 2 : Tests—Test Fc : Vibration (sinusoidal)* is identical with the said standard.

JIS C 0041 : 1995 *Basic environmental testing procedures Part 2 : Tests, Test Ea and guidance : Shock*

Remarks : IEC 60068-2-27 : 1972 *Environmental testing—Part 2 : Tests—Test Ea and guidance : Shock* is identical with the said standard.

JIS C 0047 : 1995 *Basic environmental testing procedures Part 2 : Tests Mounting of components, equipment and other articles for dynamic tests including shock (Ea), bump (Ed), vibration (Fc and Fd) and steady-state acceleration (Ga) and guidance*

Remarks : **IEC 60068-2-47** : 1982 *Basic environmental testing procedures—Part 2 : Tests Mounting of components, equipment and other articles for dynamic tests including shock (Ea), bump (Eb), vibration (Fc and Fd) and steady-state acceleration (Ga) and guidance* is identical with the said standard.

JIS C 0055 : 2000 *Environmental testing—Part 3 : Guidance. Seismic test method for equipments*

Remarks : **IEC 60068-3-3** : 1991 *Environmental testing—Part 3 : Guidance. Seismic test methods for equipments* is identical with the said standard.

ISO 266 : 1997 *Acoustics—Preferred frequencies*

ISO 2041 : 1990 *Vibration and shock—Vocabulary*

3 Definitions For the purpose of this Standard, the terms and definitions given in **ISO 2041**, **JIS C 0010**, **JIS C 0036** and **JIS C 0040**, and the following apply.

3.1 critical frequency frequencies 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.

3.2 damping generic term ascribed to the numerous energy dissipation mechanisms in a system. In practice, damping depends on many parameters, such as the structural system, mode of vibration, strain, applied forces, velocity, materials, joint slippage, etc.

3.3 critical damping minimum viscous damping that will allow a displaced system to return to its initial position without oscillation in the shortest time possible.

3.4 damping ratio ratio of actual damping to critical damping in a system with viscous damping.

3.5 signal tolerance signal tolerance:

$$T = \left(\frac{NF}{F} - 1 \right) \times 100 \quad (\text{in percentage})$$

where

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

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

3.6 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 : 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.

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

NOTE : For the purpose of this Standard, the value of g_n is rounded up to the nearest whole number, that is, 10 m/s².

Information : In Japan, SI Unit System is adopted and, therefore, this unit is not used in the Measurement Law, but this is remained here as it is.

3.8 high peaks of the response calculated peaks of the response of a single-degree-of-freedom system (oscillator), excited by a time-history, exceeding a specified threshold value (see attached figure 2).

NOTES 1 In practice, reference is made to high peaks of the response since it is difficult to identify complete response cycles due to a transient excitation (time-history).

2 The peak is a positive or a negative maximum deviation from the zero-line between two consecutive zero-crossing points (see attached figure 3).

3.9 measuring points specific points at which data are gathered for conducting the test. These points are of two main types, as defined below.

NOTE : 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.

3.9.1 check point point located on the fixture, 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.

NOTES 1 A number of check points are used as a means of ensuring that the test requirements are satisfied.

2 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.

3 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.

4 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.

3.9.2 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.

3.10 natural frequency frequency of free vibration of a structure depending only on its own physical characteristics (mass, stiffness and damping).

3.11 natural time-history recording, as a function of time, of for example acceleration, velocity or displacement, resulting from a given event.

3.12 oscillator single-degree-of-freedom system intended to produce or be capable of maintaining mechanical oscillations.

3.13 pause interval between two consecutive time-histories.

NOTE : A pause should be such as to result in no significant superposition of the response motion of the specimen and can be obtained from:

$$T > \frac{1}{f} \cdot \frac{100}{d}$$

where

T is the duration (s);

f is the lowest natural frequency (Hz);

d is the critical damping at the lowest natural frequency (in per cent).

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

3.15 random motion sample sample of random motion record modified in frequency range and amplitude so as to produce a required response spectrum.

3.16 required response spectrum response spectrum specified in the relevant specification.

3.17 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.

3.18 sampling frequency the number of discrete magnitude values taken per second to record or represent a time-history in a digital form.

3.19 strong part of the required response spectrum part of the spectrum for which the response acceleration is higher than for the -3 dB bandpass of the required response spectrum (see attached figure 4).

NOTE : Generally, for seismic applications, the strong part of the response spectrum is located in the first third of the frequency band.

3.20 strong part of the time-history part of the 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 attached figure 5).

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

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

3.23 test level largest peak value within a test wave.

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

3.25 time-history recording, as a function of time, of acceleration, velocity or displacement.

NOTE : A definition of the mathematical term "time-history" is given in **ISO 2041** and relates to the magnitude of a quantity expressed as a function of time.

3.26 zero period acceleration high-frequency asymptotic value of acceleration of the response spectrum (as an example see attached figure 6).

NOTE : 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.

4 General requirements The purpose of this test is to determine mechanical weakness and/or degradation in specified performance and to use this information, in conjunction with the relevant specification, to decide whether a specimen is acceptable or not. It may also be used, in some cases, to demonstrate the mechanical robustness of specimens and/or to study their dynamic behaviour.

The extent to which a specimen has to function during vibration or merely to survive conditions of vibration shall be stated in the relevant specification.

For the purpose of this test, the specimen is always fastened to the vibration table.

In order to facilitate the use of this Standard, references are given in the main part inviting the reader to refer to the flow chart of attached figure 1 and to annex A; the clause numbers in the main part are also referred to in annex A.

5 Requirements for testing The requirements for a vibration response investigation are given in 5.1, those for time-history testing in 5.2, while 5.3 deals with mounting for testing.

5.1 Vibration response investigation When prescribed by the relevant specification, the vibration response investigation may be carried out with reference to **JIS C 0040**, taking account of 5.1.1 to 5.1.9 below, in order to determine the critical frequencies and, where required, the damping ratio.

Random vibration testing may also be used as an alternative method for the vibration response investigation (see **JIS C 0036**, 4.3 clause A.3).