JEDEC STANDARD

Vibration, Variable Frequency

JESD22-B103B.01

(Minor revision to JESD22-B103-B, June 2002, Reaffirmed September 2010)

SEPTEMBER 2016

JEDEC SOLID STATE TECHNOLOGY ASSOCIATION

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VIBRATION, VARIABLE FREQUENCY

Foreword

The variable frequency vibration test is performed to determine the effect of vibration, within a specified frequency range, on the internal structural elements.

VIBRATION, VARIABLE FREQUENCY

(From JEDEC Board Ballot, JCB-02-32, and JCB-16-33, formulated under the cognizance of the JC-14.1 Subcommittee on Reliability Test Methods for Packaged Devices.)

1 Scope

This method is intended to evaluate component(s) for use in electrical equipment. It is intended to determine the ability of the component(s) to withstand moderate to severe vibration as a result of motion produced by transportation or field operation. Vibration of this type may disturb operating characteristics, particularly if the repetitive stress causes fatigue. This is a destructive test intended for component qualification. It is normally applicable to cavity-type packages.

2 Apparatus

Apparatus for this test shall include equipment capable of providing the required variable frequency vibration at the specified levels and the necessary optical and electrical equipment for post-test measurements.

3 Terms and definitions

3.1 RMS acceleration

The root mean square average of the acceleration interval of the dynamic motion.

3.2 Peak acceleration

The maximum of the acceleration interval of the dynamic motion.

3.3 Logarithmic sweep

Continuously varying the frequency in a manner such that within any portion of the frequency range, a fixed number of decades is traversed in a fixed length of time.

3.4 Octave

A measurement of the spacing of frequency characterized by a doubling of frequency. The number of octaves, N, between two frequencies, f1<f2, is given by N=(log f2/f1) / log 2.

3.5 Decade

A measurement of the spacing of frequency characterized by a tenfold increase of frequency. The number of decades, D, between two frequencies, f1<f2, is given by D= (log f2/f1) / log 10.

3 Terms and definitions (cont'd)

3.6 Decibel measurement of PSD, dB

A measurement of the ratio R of one level of power spectral density, s1, relative to another reference level, s2, given by the formula R = 20 log (s1 / s2) / log 10. R=6dB is approximately a doubling of power spectral density from one level to another.

3.7 Power spectral density, PSD

A measurement of the intensity of acceleration power per unit frequency, in units of G squared per Hz.

3.8 Service condition

The designation of the severity of test used to evaluate a component.

3.9 Velocity change

The integral of the acceleration interval of the dynamic motion over the interval.

3.10 Cavity package

A component that has the device located within the cavity of the package body.

3.11 Peak-peak displacement

The maximum difference between highest and lowest values of the displacement of the dynamic motion interval.

3.12 Gaussian random vibration

Vibration characterized by having acceleration and frequency values over an interval of time which occur in a stochastic manner, with the acceleration values following a normal (Gaussian) probability density function and frequency values following a uniform distribution.

4 Procedure

4.1 Component selection

Components subjected to the test will be randomly selected and typical of production. The component shall be rigidly mounted or restrained by its case with suitable protection for the leads. If component rework, burn in or other stressful process is to be considered, then such a process or processes should be applied to the component(s) prior to vibration test. Use of such processes in the test hardware preparation will be documented in the test results.

4.2 Required stress application - swept sine test

4.2.1 Mounting the component

The device case shall be rigidly fastened on the vibration platform and the leads adequately secured to avoid excessive lead resonance. The components will be mounted in such a manner so that they experience the full-specified vibration level at the component.

4.2.2 Vibration application

Vibration will be applied to the component's outer surface casing or leads in a manner to simulate expected vibration during non-shipment conditions. The devices shall be vibrated with simple harmonic motion corresponding to the test levels shown in Table 1. At least one service condition must be designated. Each test level will include simple harmonic motion of continuously swept frequency with the indicated peak-peak displacement below the crossover frequency, and indicated peak acceleration above the crossover frequency. A tolerance level of +/- 10% on the test being performed, either displacement or acceleration, is allowed. The test frequency range is from the indicated minimum frequency to the indicated maximum test frequency. A complete sweep of the test frequency range, from the minimum to maximum and return to the minimum frequency, shall be traversed in a logarithmic manner, in 4 minutes. The sweep rate is 1 decade/minute. This complete sweep shall be performed 4 times in each of the orientations X, Y, and Z (total of 12 times). If there are no significant stress sensitivities of the component under test in a particular frequency range (for examples, in the lower frequency ranges, or in a region of an uncontrollable fixture resonance), then that portion of the frequency sweep may be deleted from the stress application with full documentation of the reasons for the test exception and extent of the portion(s) of the sweep test deleted.

Table 1 — Component test levels

Service condition	Peak acceleration (G)	Displacement pk-pk (in / mm)	Cross-over frequency (Hz)	Min. / Max. frequency (Hz)
1	20	0.060 / 1.5	80	20 / 2000
2	10	0.040 / 1.0	70	10 / 1000
3	3	0.030 / 0.75	45	5 / 500
4	1	0.020 / 0.5	31	5 / 500
5	0.3	0.010 / 0.25	24	5 / 500
6	0.1	0.005 / 0.125	20	5 / 500
7	0.01	0.001 / 0.039	14	5 / 500
8	0.001	0.0005 / 0.0127	6.2	5 / 500

4.3 Optional stress application - Random vibration test

4.3.1 Mounting component

The device case shall be rigidly fastened on the vibration platform and the leads adequately secured to avoid excessive lead resonance. The components will be mounted in such a manner so that they experience the full-specified vibration level at the component.

4.3 Optional stress application - Random vibration test (cont'd)

4.3.2 Vibration application

Vibration will be applied to the component's outer surface casing or leads in a manner to simulate expected vibration during packaged shipment. The devices shall be vibrated with Gaussian random vibration corresponding one of the service conditions with associated overall test level as shown in Table 2. Details of the power spectral density PSD functions for these test levels are given in Table 3, Table 4, Table 5, and Table 6 as breakpoints of the curves. Table 3, Table 4, Table 5, and Table 6 are plotted out in the curves found in Figure 1. In general, Component test levels A, B and C represent shipping conditions for the component, with condition A being the most extreme. Test conditions D - I represent various levels of application vibrations to which a component can be exposed. Condition D is the most severe. Selection of the appropriate test condition should be based on the actual shipping or application condition requirement for the component. The vibration will be applied for 30 minutes in each of 3 orthogonal axes, for every service condition. At least one service condition must be designated, and subjected to the required test level for a minimum of 90 minutes in total, to complete all three axes.

Table 2 — Overall measures of random vibration test levels

Service condition	RMS acceleration (G)	RMS velocity (in/sec)	RMS displacement (in)	6* RMS displacement, or 3 sigma pk-pk displacement (in)
A	6.27	29.0	0.926	5.55
B	3.10	13.2	0.426	2.56
C	1.24	5.22	0.178	1.07
D	1.11	1.64	0.0310	0.186
E	0.686	0.703	0.00543	0.0326
F	0.416	0.425	0.00355	0.0213
G	0.246	0.215	0.00171	0.0102
H	0.123	0.113	0.000832	0.00499
I	0.0626	0.0589	0.000395	0.002237

4.3.3 Test tolerances

The PSD test level will be applied within a tolerance +/- 6 dB of the nominal values at any frequency, and with an overall tolerance on the RMS acceleration levels of +/- 10%, employing suitable averaging technique. If there are no significant stress sensitivities of the component under test in a particular frequency range (for examples, in the lower frequency ranges, or in a region of an uncontrollable fixture resonance), then that portion of the PSD spectrum may be deleted from the stress application with full documentation of the reasons for the test exception and extent of the portion(s) of the PSD spectrum deleted.

4.3 Optional stress application - Random vibration test (cont'd)

Table 3 — Frequency breakpoints of power spectral density of component test levels A, B, C

	Service condition A	Service condition B	Service condition C
Frequency (Hz)	**PSD level, G squared/Hz**	**PSD level, G squared/Hz**	**PSD level, G squared/Hz**
2	0.01	0.003	0.001
4	1	0.2	0.03
8	1	0.2	0.03
40	0.1	0.02	0.003
50	0.3	0.08	0.013
70	0.3	0.08	0.013
200	0.03	0.008	0.001
500	0.01	0.003	0.001

Table 4 — Frequency breakpoints of power spectral density of component test level D

	Service condition D
Frequency (Hz)	**PSD Level, G squared / Hz**
3	0.0001
6	0.003
40	0.003
50	0.013
70	0.013
200	0.001
500	0.001

Table 5 — Frequency breakpoints of power spectral density of component test levels E, F

	Service Condition E	Service Condition F
Frequency (Hz)	**PSD Level, G squared / Hz**	**PSD Level, G squared / Hz**
5	0.00002	0.00001
17	0.001	0.0004
40	0.001	0.0004
50	0.01	0.003
60	0.01	0.003
70	0.001	0.0004
150	0.001	0.0004
200	0.0005	0.0002
500	0.0005	0.0002

4.3 Optional stress application - Random vibration test (cont'd)

Table 6 — Frequency breakpoints of power spectral density of component test levels G, H, I.

	Service Condition G	Service Condition H	Service Condition I
Frequency (Hz)	**PSD Level, G squared / Hz**	**PSD Level, G squared / Hz**	**PSD Level, G squared / Hz**
5	0.000002	0.0000005	0.0000001
17	0.0001	0.0000022	0.0000005
40	0.0001	0.0000022	0.0000005
50	0.0008	0.0003	0.0001
60	0.0008	0.0003	0.0001
70	0.0001	0.0000022	0.0000005
500	0.00001	0.0000022	0.0000005

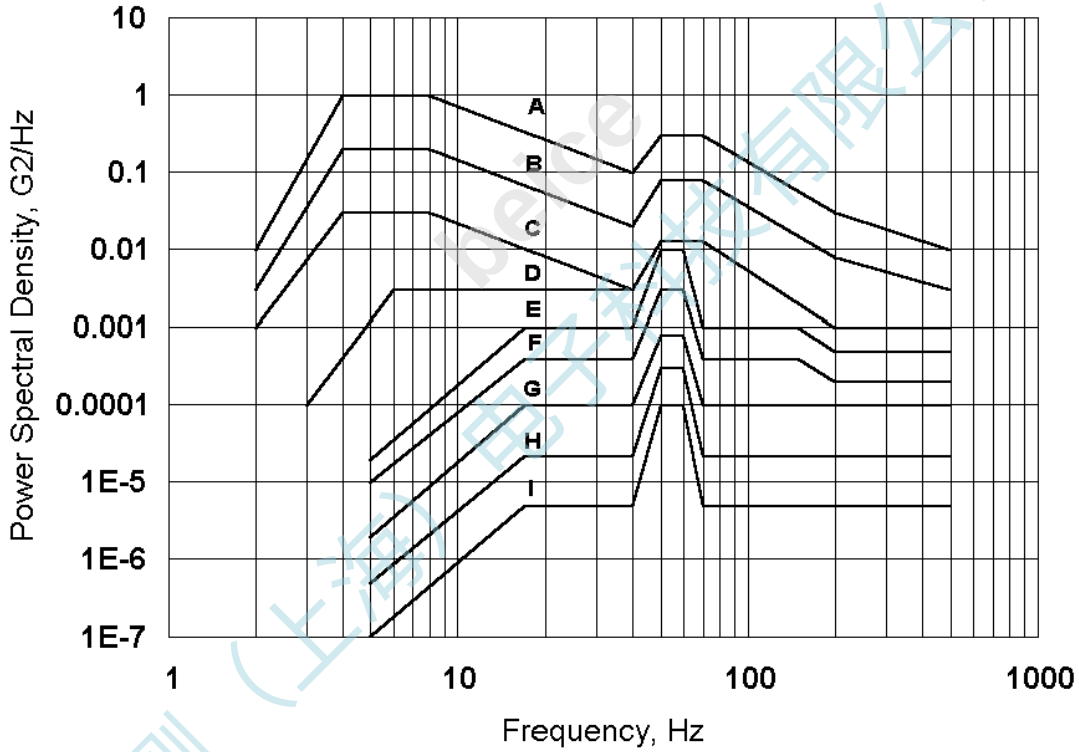

Figure 1 — Random vibration tests, power spectral density

4.4 Measurements

Hermeticity tests, if applicable, visual examination and electrical measurements (consisting of parametric and functional tests) shall be performed.

5 Failure Criteria

A component shall be defined as a failure if hermeticity requirements cannot be demonstrated, if parametric limits are exceeded or if functionality cannot be demonstrated under the conditions specified in the applicable procurement document.

Mechanical damage, such as cracking, chipping or breaking of the package will also be considered a failure provided such damage was not caused by fixturing or handling and the damage is critical to component performance in the specific application.

6 Summary

The following details shall be specified in the applicable procurement document:

a) Test service condition, for each test performed.

b) Electrical measurements and results.

c) Sample size and accept number.

d) Disposition of failures.

e) Hermetic leak rate (if applicable).

f) Description of mounting fixture, how component was supported, any pressure applied to component.

g) Description of component, and if applicable, component pre-test stress history.

h) Description of any exceptions to stress application, reason for need for exception, and description of reason(s) why omission of the stress application will not materially affect test outcome.

Annex A (informative) Other standards used for shipping risks

ASTM D4728, *Standard Test Method for Random Vibration Testing of Shipping Containers*

ASTM D999, *Standard Test Methods for Vibration Testing of Shipping Containers*

ISTA

MIL-STD-810, *Environmental Engineering Considerations and Laboratory Tests*

A.1 Vibration standards for automotive sector

AEC Q-100, *Failure Mechanism Based Stress Test Qualification For Integrated Circuits*

A.2 Vibration standards for electrical connectors

Telcordia GR-1217-Core, *Generic Requirements for Separable Electrical Connectors Used in Telecommunications Hardware*

EIA364-28, *Vibration Test Procedure for Electrical Connectors and Sockets*

A.3 Vibration standards for component testing

MIL-STD-202, *Test Method Standard for Electronic and Electrical Component Parts*

MIL-STD-750, *Test Methods for Semiconductor Devices*

MIL-STD-883, *Test Method Standard for Microcircuits*

Annex B (informative) Differences between JESD22-B103B.01 and JESD22-B103-B

This annex briefly describes most of the changes made to entries that appear in this standard, JESD22-B103B.01, compared to its predecessor, JESD22-B103-B (June 2002). Some punctuation changes are not included.

Clause	Page Term and description of change
4.2.2	1st paragraph, end of 1st sentence: changed “processing and packaged shipment” to “non-shipment conditions”
4.2.3	1st paragraph, end of 1st sentence: changed “processing and packaged shipment” to “packaged shipment”
4.3	Table 6, for Frequency 17, Frequency 40, Frequency 70, and Frequency 500, under Service condition I, changed: “0.000005” to “0.0000005”
Annex A	Added

Standard Improvement Form JEDEC _____

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1. I recommend changes to the following:

☐ Requirement, clause number _____

☐ Test method number _____ Clause number _____

The referenced clause number has proven to be:

☐ Unclear ☐ Too Rigid ☐ In Error

☐ Other _____

2. Recommendations for correction:

_____

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3. Other suggestions for document improvement:

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