INTERNATIONAL STANDARD

ISO 16750-3

Second edition
2007-08-01

Road vehicles — Environmental conditions and testing for electrical and electronic equipment —

Part 3: Mechanical loads

Véhicules routiers — Spécifications d'environnement et essais des équipements électrique et électronique —
Partie 3: Contraintes mécaniques

Reference number
ISO 16750-3:2007(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 16750-3 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This second edition cancels and replaces the first edition (ISO 16750-3:2003), which has been technically revised.

ISO 16750 consists of the following parts, under the general title *Road vehicles — Environmental conditions and testing for electrical and electronic equipment*:

— *Part 1: General*

— *Part 2: Electrical loads*

— *Part 3: Mechanical loads*

— *Part 4: Climatic loads*

— *Part 5: Chemical loads*

Road vehicles — Environmental conditions and testing for electrical and electronic equipment —

Part 3: Mechanical loads

1 Scope

This part of ISO 16750 applies to electric and electronic systems/components for road vehicles. This part of ISO 16750 describes the potential environmental stresses, and specifies tests and requirements recommended for the specific mounting location on/in the vehicle.

This part of ISO 16750 describes the mechanical loads.

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.

ISO 16750-1, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 1: General*

ISO 16750-4, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads*

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

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

IEC 60068-2-29, *Environmental testing — Part 2: Tests — Test Eb and guidance: Bump*

IEC 60068-2-32, *Environmental testing — Part 2: Tests — Test Ed: Free fall*

IEC 60068-2-64, *Environmental testing — Part 2: Test methods — Test Fh: Vibration, broad-band random (digital control) and guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16750-1 apply.

4 Tests and requirements

4.1 Vibration

4.1.1 General

The vibration test methods specified consider various levels of vibration severities applicable to on-board electrical and electronic equipment. It is recommended that vehicle manufacturer and supplier choose the test method, the environmental temperature and vibration parameters depending on the specific mounting location.

The specified values apply to direct mounting in defined mounting locations. The use of a bracket for mounting can result in higher or lower loads. If the device under test (DUT) is used in the vehicle with a bracket, then all vibration and mechanical shock testing shall be done with this bracket.

Carry out the vibration test with the DUT suitably mounted on a vibration table. The mounting method(s) used shall be noted in the test report. Carry out the frequency variation by logarithmic sweeping of 0,5 octave/minute for sinusoidal tests and the sinusoidal part of sine on random tests. The objective of the recommended vibration tests is to avoid malfunctions and breakage mainly due to fatigue in the field. Testing for wear has special requirements and is not covered in this part of ISO 16750.

Loads outside the designated test frequency ranges shall be considered separately.

NOTE Deviations from the load on the DUT can result if vibration testing is carried out in accordance with this part of ISO 16750 on a heavy and bulky DUT, as mounting rigidity and dynamic reaction on the vibrator table excitation are different compared to the situation in the vehicle. This deviation can be minimized by applying the average control method (see Annex A).

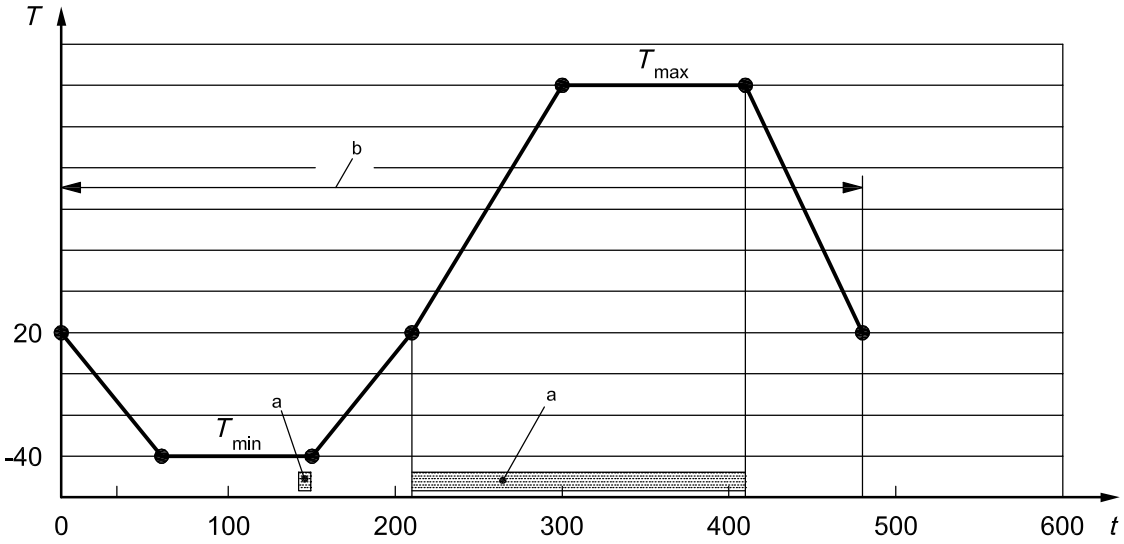
Application of the weighted average control method in accordance with IEC 60068-2-64 shall be agreed upon.

Subject the DUT during the vibration test to the temperature cycle in accordance with IEC 60068-2-14, with electric operation in accordance with Figure 1. Alternatively, a test at constant temperature may be agreed between customer and supplier.

Operate the DUT electrically as indicated in Figure 1 at T_{min} (short functional test after the DUT has reached T_{min} completely). This functional test shall be as short as possible, i.e. only long enough to check the proper performance of the DUT. This minimizes self-heating of the DUT. Additional electrical operation of the DUT takes place between 210 min and 410 min of the cycle (see Figure 1).

Additional drying of test chamber air is not permitted.

Because in the vehicle vibration stress can occur together with extremely low or high temperatures, this interaction between mechanical and temperature stress is simulated in the test, too. The failure mechanism is, for example, a plastic part of a system/component that mellows due to the high temperature and cannot withstand the acceleration under this condition.



Key

T temperature, °C

t time, min

[a] Operating mode 3.2 in accordance with ISO 16750-1.

[b] One cycle.

Figure 1 — Temperature profile for the vibration test

Table 1 — Temperature versus time for the vibration test

Duration min	Temperature °C
0	20
60	–40
150	–40
210	20
300	T_{max} [a]
410	T_{max} [a]
480	20
[a] For T_{max}, see ISO 16750-4.	

4.1.2 Tests

4.1.2.1 Test I — Passenger car, engine

4.1.2.1.1 Purpose

This test checks the DUT for malfunctions and breakage caused by vibration.

The vibrations of a piston engine can be split up into two kinds:

— sinusoidal vibration that results from the unbalanced mass forces in the cylinders, and

— random noise due to all other vibration-schemes of an engine, e.g. closing of valves.

In the lowest frequency range from 10 Hz to 100 Hz, the influence of rough-road conditions is taken into account. The main failure to be identified by this test is breakage due to fatigue.

NOTE Road profile usually has negligible impact on engine mounted components. Shock inputs are effectively isolated by the suspension of motor mounting systems.

The test profiles specified in the following clauses (4.1.2.1.2 to 4.1.2.1.3) apply to loads generated by (four stroke) reciprocating engines.

It is recommended to perform this test as a mixed mode vibration test in accordance with IEC 60068-2-80. Alternatively these tests may be performed sequentially.

4.1.2.1.2 Test

4.1.2.1.2.1 Sinusoidal vibration

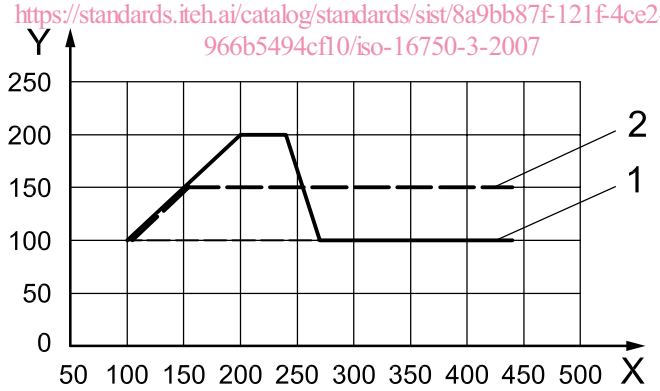
Perform the test in accordance with IEC 60068-2-6. Unlike in IEC 60068-2-6, a sweep rate of 0,5 octave/minute or less shall be used. Use a test duration of 22 h for each plane of the DUT.

NOTE The test duration is based on A.4. The temperature in the chamber is above room temperature (RT) at the end of the test (2,75 temperature cycles).

Use curve 1 in Table 2 and Figure 2 for DUT intended for mounting on engines with five cylinders or less.

Use curve 2 in Table 2 and Figure 2 for DUT test intended for mounting on engines more than five cylinders or more.

Both curves may be combined to cover all engine types in one test.



Key

X frequency, Hz

Y maximum acceleration, m/s^2

1 curve 1 ($\leqslant$ five cylinders)

2 curve 2 ($>$ five cylinders)

Figure 2 — Vibration severity curves

Table 2 — Values for maximum acceleration versus frequency

Curve 1 (see Figure 2)	
Frequency Hz	**Maximum acceleration** m/s^2
100	100
200	200
240	200
270	100
440	100

Curve 2 (see Figure 2)	
Frequency Hz	**Maximum acceleration** m/s^2
100	100
150	150
440	150

Combination	
Frequency Hz	**Maximum acceleration** m/s^2
100	100
150	150
200	200
240	200
255	150
440	150

4.1.2.1.2.2 Random vibration

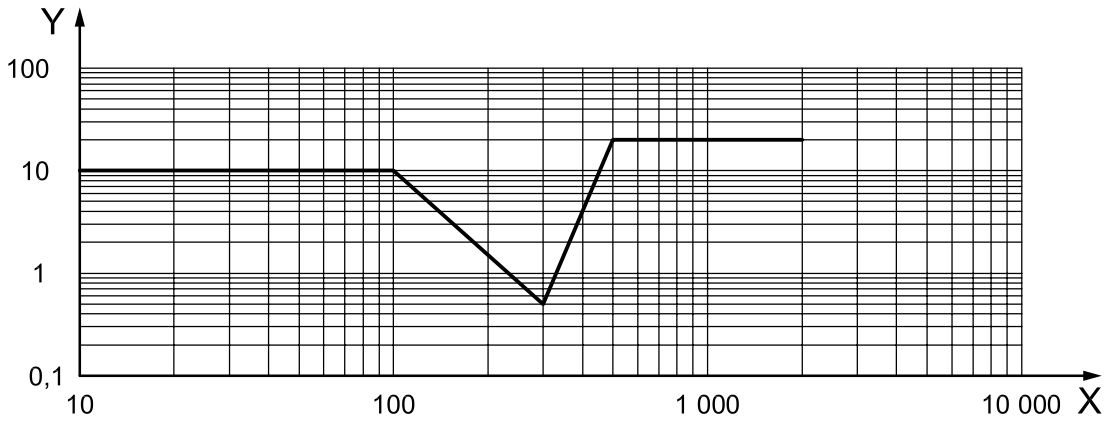
Perform the test in accordance with IEC 60068-2-64. Use a test duration of 22 h for each plane of the DUT.

NOTE The test duration is based on A.4. The temperature in the chamber is above RT at the end of the test (2,75 temperature cycles).

The r.m.s. acceleration value shall be 181 m/s^2.

The power spectral density (PSD) versus frequency is illustrated in Figure 3 and Table 3.

NOTE The PSD values (random vibration) are reduced in the frequency range of the sinusoidal vibration test.



Key

X frequency, Hz

Y power spectral density, $(m/s^2)^2/Hz$

Figure 3 — PSD of acceleration versus frequency

Table 3 — Values for frequency and PSD

Frequency Hz	**PSD** $(m/s^2)^2/Hz$
10	10
100	10
300	0,51
500	20
2 000	20

4.1.2.1.3 Requirement

Breakage shall not occur.

As defined in ISO 16750-1, functional status class A is required during operating mode 3.2, and functional status class C during periods with other operating modes.

4.1.2.2 Test II — Passenger car, gearbox

4.1.2.2.1 Purpose

This test checks the DUT for malfunctions and breakage caused by vibration.

The vibrations of a gearbox can be split up into two kinds, which result partly from sinusoidal vibration from unbalanced mass forces of the engine (e.g. dominating orders) in the frequency range from 100 Hz to 440 Hz, and vibration from the friction of the gear wheels and other schemes, which are tested in the random part. In the lowest frequency range from 10 Hz to 100 Hz, the influence of rough-road conditions is taken into account. The main failure to be identified by this test is breakage due to fatigue.

The test profiles specified in the following clauses apply to loads generated by gearbox vibrations. Changing the gears can create additional mechanical shock and shall be considered separately.

It is recommended to perform this test as a mixed mode vibration test in accordance with IEC 60068-2-80. Alternatively these tests may be performed sequentially.

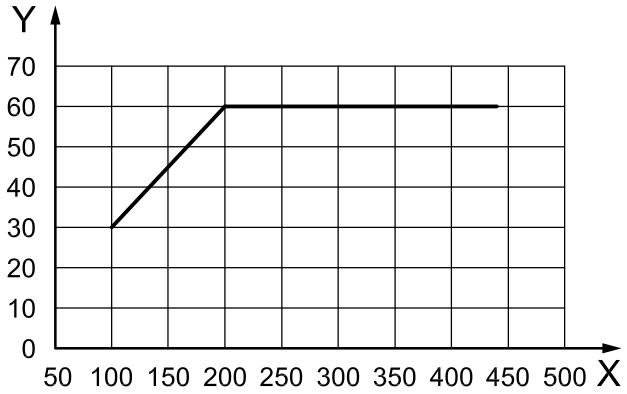
4.1.2.2.2 Test

4.1.2.2.2.1 Sinusoidal vibration

Perform the test in accordance with IEC 60068-2-6. Unlike in IEC 60068-2-6, a sweep rate of 0,5 octave/minute or less shall be used. Use a test duration of 22 h for each plane of the DUT.

NOTE The test duration is based on A.4. The temperature in the chamber is above RT at the end of the test (2,75 temperature cycles).

The amplitude versus frequency is illustrated to in Figure 4 and Table 4.



Key

X frequency, Hz

Y maximum acceleration, m/s^2

Figure 4 — Maximum versus frequency

Table 4 — Values for maximum acceleration versus frequency

Frequency Hz	Maximum acceleration m/s^2
100	30
200	60
440	60

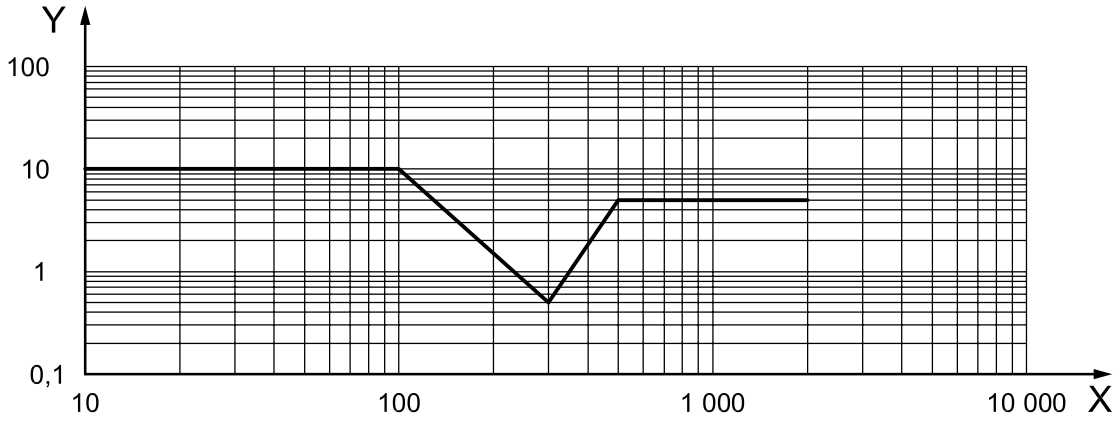
4.1.2.2.2.2 Random vibration

Perform the test in accordance with IEC 60068-2-64. Use a test duration of 22 h for each plane of the DUT.

The r.m.s. acceleration value shall be 96,6 m/s^2.

NOTE The PSD values (random vibration) are reduced in the frequency range of the sinusoidal vibration test.

The PSD versus frequency is illustrated to in Figure 5 and Table 5.



Key

X frequency, Hz

Y power spectral density, $(m/s^2)^2/Hz$

Figure 5 — PSD of acceleration versus frequency

Table 5 — Values for frequency and PSD

Frequency Hz	PSD $(m/s^2)^2/Hz$
10	10
100	10
300	0,51
500	5
2 000	5

4.1.2.2.3 Requirement

Breakage shall not occur.

As defined in ISO 16750-1, functional status class A is required during operating mode 3.2, and functional status class C during periods with other operating modes.

4.1.2.3 Test III — Passenger car, flexible plenum chamber

4.1.2.3.1 Purpose

This test checks the DUT for malfunctions and breakage caused by vibration.

This test is applicable to equipment to be mounted on a flexible plenum chamber but not rigidly attached.

The vibrations in this mounting location are sinusoidal and mainly induced by the pulsation of the intake air.

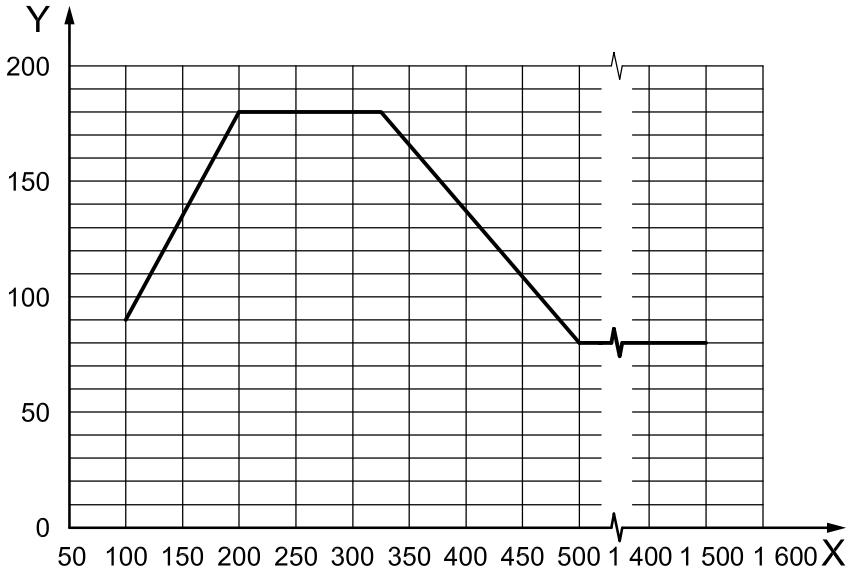
The main failure to be identified by this test is breakage due to fatigue.

4.1.2.3.2 Test

Perform the test in accordance with IEC 60068-2-6. Unlike in IEC 60068-2-6, a sweep rate of 0,5 octave/minute or less shall be used. Use a test duration of 22 h for each plane of the DUT.

NOTE The test duration is based on A.4. The temperature in the chamber is above RT at the end of the test (2,75 temperature cycles).

The amplitude versus frequency is illustrated in Figure 6 and Table 6.



Key

X frequency, Hz

Y maximum acceleration, m/s^2

Figure 6 — Maximum acceleration versus frequency

Table 6 — Values for maximum acceleration versus frequency

Frequency Hz	Maximum acceleration m/s^2
100	90
200	180
325	180
500	80
1 500	80

4.1.2.3.3 Requirement

Breakage shall not occur.

As defined in ISO 16750-1, functional status class A is required during operating mode 3.2, and functional status class C during periods with other operating modes.

4.1.2.4 Test IV — Passenger car, sprung masses (vehicle body)

4.1.2.4.1 Purpose

This test checks the DUT for malfunctions and breakage caused by vibration.

Vibration of the body is random vibration induced by rough-road driving. The main failure to be identified by this test is breakage due to fatigue.