INTERNATIONAL STANDARD

ISO 16750-3

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

Part 3: Mechanical loads

Véhicules routiers — Spécifications d'environnement et essais de l'équipement électrique et électronique —

Partie 3: Contraintes mécaniques

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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*.

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 describes the mechanical loads that can affect electric and electronic systems and components in respect of their mounting directly on or in road vehicles, and specifies the corresponding tests and requirements.

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 16750-1:2003, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 1: General*

ISO 16750-4:2003, *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*

IEC 60068-2-80, *Environmental testing — Part 2: Tests — Test Fi: Mixed mode*[1)]

DIN 55996-1, *Paints and varnishes — Stone chip resistance test for coatings — Part 1: Multi-impact test*

3 Terms and definitions

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

1) To be published.

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 the 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. Using a bracket for mounting can result in higher or lower loads. If the electronic control unit (ECU) is used in the vehicle with a bracket, then all vibration and mechanical shock tests shall be done with this bracket.

Carry out the vibration with the device under test (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 1 octave/min for sinusoidal tests. The motion shall be applied in each of the three mutually perpendicular axes for a duration as defined for each test.

The scope of the recommended test profiles and test duration is aimed at avoiding fatigue failure. Testing for wear has special requirements and is not covered in this part of ISO 16750.

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

NOTE Deviations from the load on the DUT can result, should vibration testing be carried out according to this standard 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).

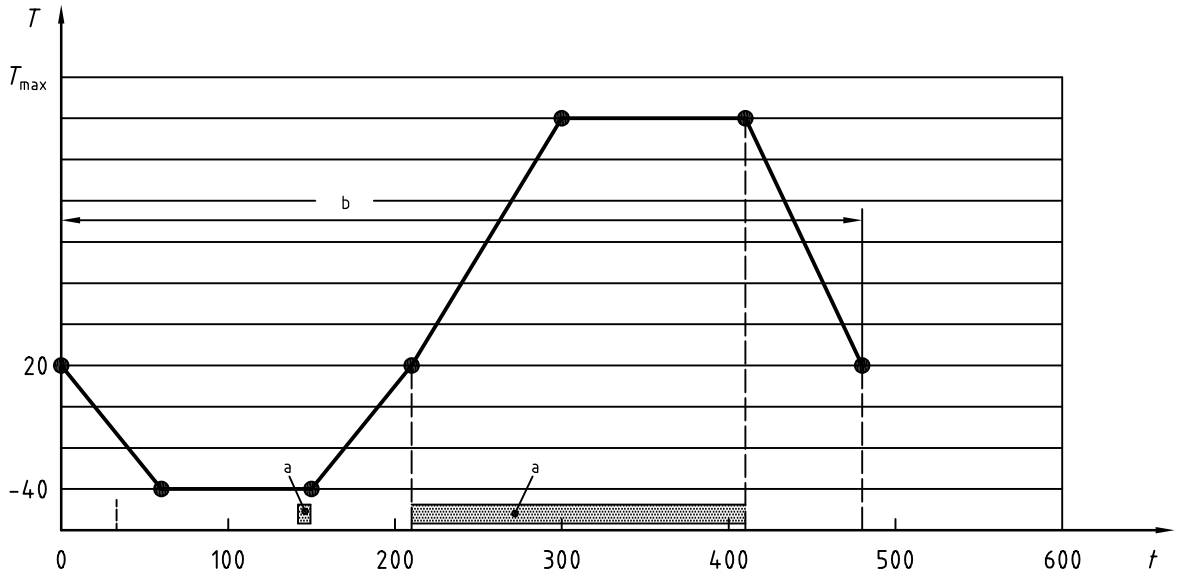
Application of the average control method according to IEC 60068-2-64 is to be agreed upon.

Subject the DUT during the vibration test to the temperature cycle according to IEC 60068-2-14, with electric operation in accordance with Figure 1. Alternatively, a test at constant temperature (RT) may be agreed upon and performed.

Operate the DUT electrically as indicated in Figure 1 at T_{min}, in a short functional test performed after the DUT has completely reached T_{min}. This functional test shall be as short as possible: long enough only such that the proper performance of the DUT can be checked. This minimizes self-heating of the ECU. Additional electrical operation of the DUT between the 210th minute and the 410th minute of the cycle (see Figure 1).

Additional drying of test chamber air is not permitted.

Owing to the fact that 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, which mellows due to the high temperature and cannot withstand the acceleration under this condition.



Key

t time, min
T temperature, °C

a Operating mode 3.2 (see ISO 16750-1:2003).
b One cycle.

Figure 1 — Temperature profile for vibration test

Table 1 — Temperature vs. time for 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] See ISO 16750-4:2003, Table 1.

4.1.2 Requirements

For all vibration tests, Functional status A as defined in ISO 16750-1:2003 shall be used when in Operating mode 3.2 in accordance with ISO 16750-1:2003, Clause 5, and Functional status C shall be used during periods in other operating modes.

4.1.3 Tests

4.1.3.1 Test Set 1 — Equipment for passenger cars

4.1.3.1.1 General

This test set (Tests I to V) is recommended mainly for testing equipment for passenger cars.

4.1.3.1.2 Test I — Equipment mounted directly on the engine

4.1.3.1.2.1 Purpose

The vibrations of a piston engine can be divided into two types: sinusoidal vibration resulting from the unbalanced mass forces in the cylinders, and random noise from all other vibration sources of an engine, e.g. closing of valves. Failure mode in this test is rupture owing to fatigue.

NOTE The temperature in the chamber is above room temperature at the end of the test (2,75 temperature cycles).

The test profiles specified in the following subclauses apply to loads generated by (four-stroke) reciprocating engines.

Following the forthcoming publication of IEC 60068-2-80, and the determination of the test parameters in accordance with it, this test should be performed as a combined sine and random test, also according to IEC 60068-2-80. Alternatively, these tests may be performed sequentially.

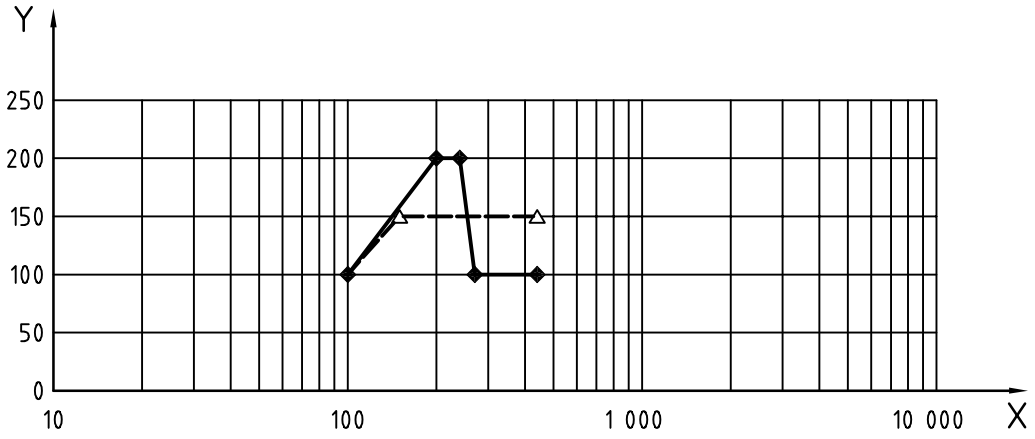
4.1.3.1.2.2 Sinusoidal vibration

Perform the test according to IEC 60068-2-6. The test duration shall be 22 h for each plane of the DUT. The amplitude of acceleration and the frequency shall be in accordance with Figure 2 and Table 2, as follows:

— use Curve 1 for DUTs intended for mounting on engines with five cylinders or less;

— use Curve 2 for DUTs intended for mounting on engines with six or more cylinders.

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



Key

X frequency, Hz

Y amplitude of acceleration, m/s^2

Curve 1 (engines with 5 cylinders or less)

Curve 2 (engines with 6 or more cylinders)

Figure 2 — Vibration severity curves

Table 2 — Values for frequency and acceleration

Curve 1 (see Figure 2)		Curve 2 (see Figure 2)		Combination	
Frequency Hz	**Amplitude of acceleration** m/s^2	**Frequency** Hz	**Amplitude of acceleration** m/s^2	**Frequency** Hz	**Amplitude of acceleration** m/s^2
100	100	100	100	100	100
200	200	150	150	150	150
240	200	440	150	200	200
270	100			240	200
440	100			255	150
				440	150

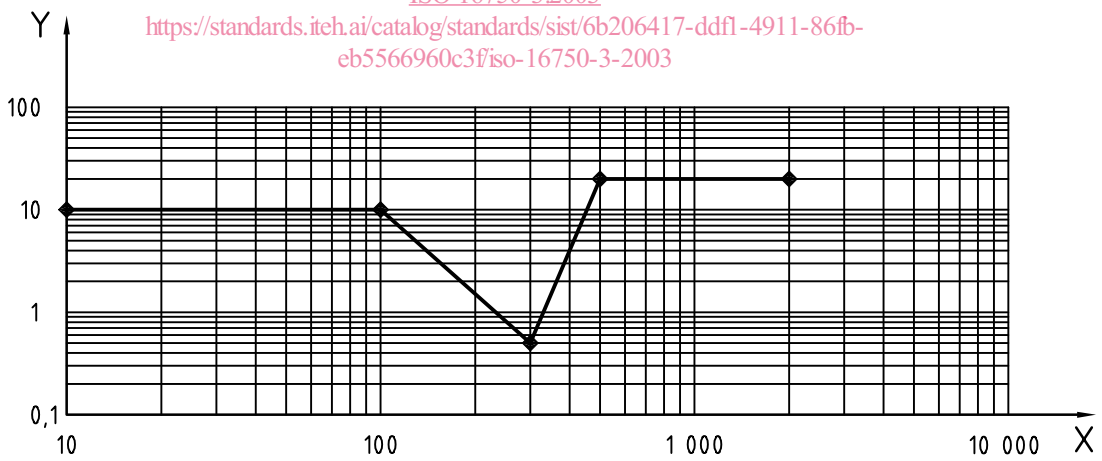
4.1.3.1.2.3 Random vibration

Perform the test according to IEC 60068-2-64. The test duration shall be 22 h for each plane of the DUT.

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

See 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 (PSD) of acceleration, $(m/s^2)^2/Hz$

Figure 3 — PSD of acceleration vs. frequency

Table 3 — Values for frequency and power spectral density

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

4.1.3.1.3 Test II — Gear box mounted equipment

4.1.3.1.3.1 Purpose

The vibrations of a gear box can be divided into two types, resulting partly from vibrations transmitted from the engine: sinusoidal vibration, which results from unbalanced mass forces, and random noise created by the friction of the gearwheels and other vibration sources in the engine. Failure mode in this test is rupture due to fatigue.

NOTE The temperature in the chamber is above room temperature at the end of the test (2,75 temperature cycles).

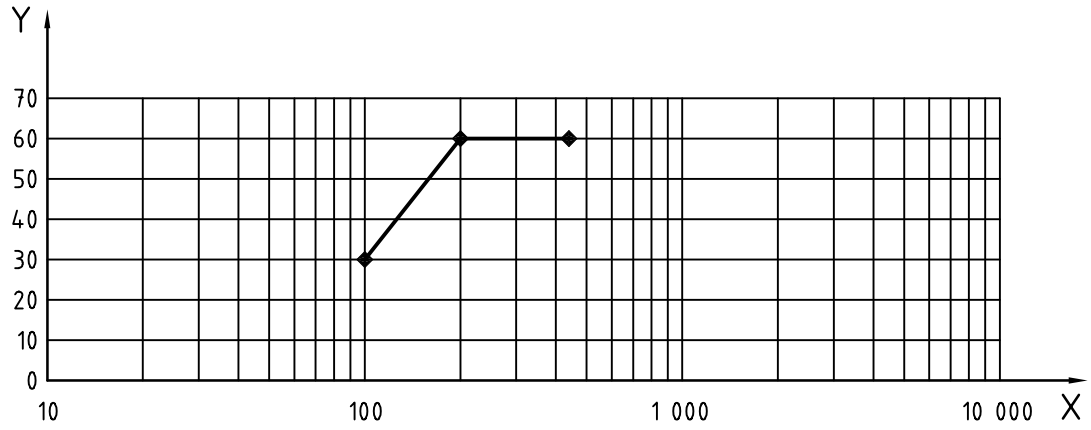
The test profiles specified in the following subclauses apply to loads generated by gear box vibrations. Changing the gears can create additional mechanical shock and shall be considered separately.

Following the forthcoming publication of IEC 60068-2-80, and the determination of the test parameters in accordance with it, this test should be performed as a combined sine and random test, also according to IEC 60068-2-80. Alternatively, these tests may be performed sequentially.

4.1.3.1.3.2 Sinusoidal vibration

Perform the test according to IEC 60068-2-6. The test duration shall be 22 h for each plane of the DUT.

See Figure 4 and Table 4.



Key

X frequency, Hz

Y amplitude of acceleration, m/s^2

Figure 4 — Acceleration vs. frequency

Table 4 — Values for frequency and acceleration

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

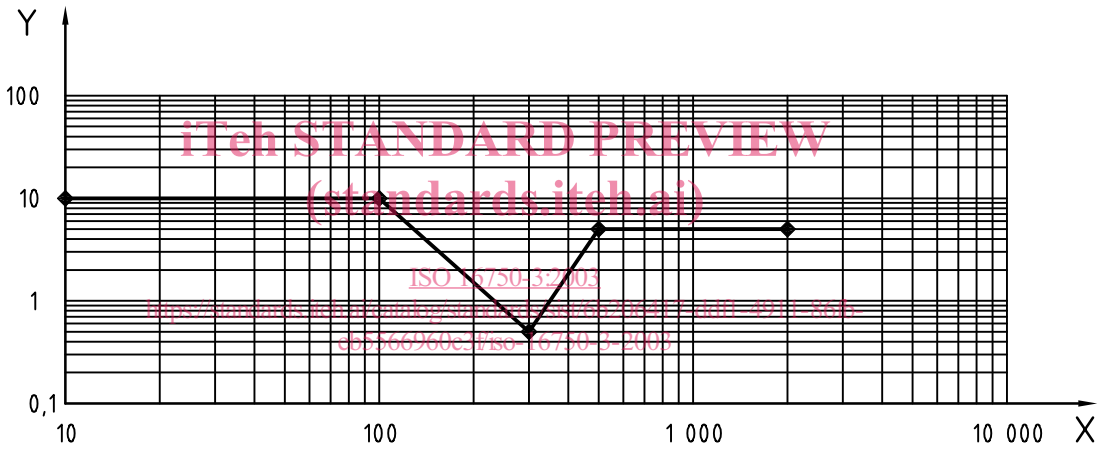
4.1.3.1.3.3 Random vibration

Perform the test according to IEC 60068-2-64. The test duration shall be 22 h for each plane of the DUT.

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

See Figure 5 and Table 5.

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 (PSD) of acceleration, $(m/s^2)^2/Hz$

Figure 5 — PSD of acceleration vs. frequency

Table 5 — Values for frequency and power spectral density

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

4.1.3.1.4 Test III — Equipment mounted on flexible plenum chamber but not rigidly attached

4.1.3.1.4.1 Purpose

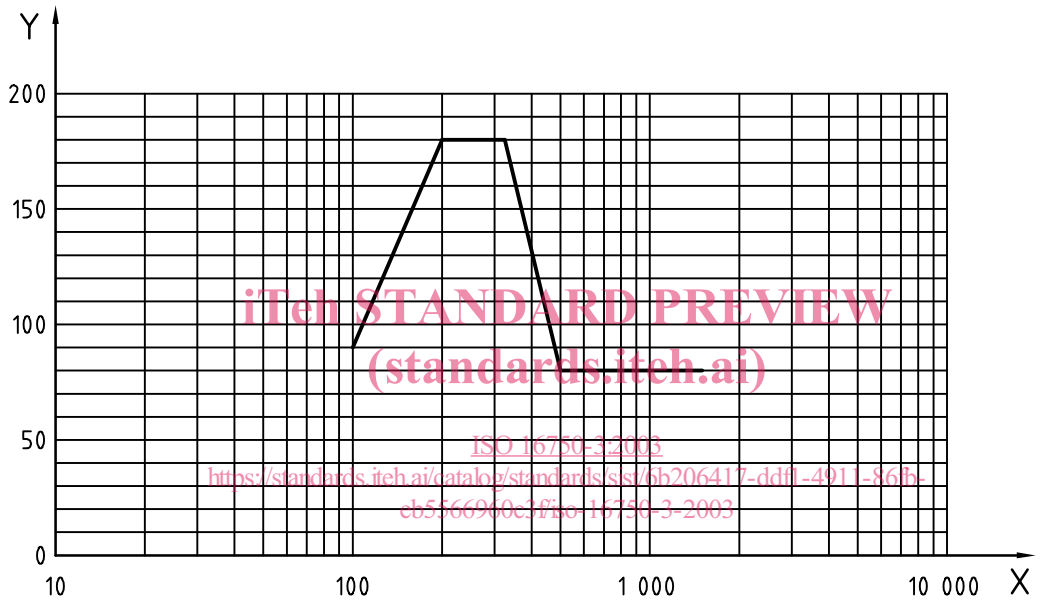
The vibrations in this mounting location are sinusoidal and are mainly induced by the pulsation of the intake air. Failure mode is rupture due to fatigue.

4.1.3.1.4.2 Test

Perform the test according to IEC 60068-2-6. The test duration shall be 22 h for each plane of the DUT.

NOTE The temperature in the chamber is above room temperature at the end of the test (2,75 cycles).

See Figure 6 and Table 6.



Key

X frequency, Hz

Y amplitude of acceleration, m/s^2

Figure 6 —Acceleration vs. frequency

Table 6 — Values for frequency and acceleration

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