INTERNATIONAL STANDARD

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Road vehicles — Measurement techniques in impact tests — Instrumentation

Véhicules routiers — Techniques de mesurage lors des essais de choc — Instrumentation

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 6487 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 12, *Passive safety crash protection systems*.

This fourth edition cancels and replaces the third edition (ISO 6487:2000), which has been technically revised.

Annex A forms a normative part of this International Standard. Annex B is for information only.

Introduction

This edition of ISO 6487 is the result of a willingness to harmonize the previous edition, ISO 6487:2000, and the American Society of Automotive Engineers' standard, SAE J211:1995.

It presents a series of performance requirements concerning the whole measurement sequence of impact shocks.

These requirements may not be altered by the user and all are obligatory for any agency conducting tests to this International Standard. However, the method of demonstrating compliance with them is flexible and can be adapted to suit the needs of the particular equipment used by a testing agency.

This approach affects the interpretation of requirements. For example, there is a requirement to calibrate within the working range of the channel, i.e. between F_L and $F_H/2,5$. This cannot be interpreted literally, as low-frequency calibration of accelerometers requires large displacement inputs beyond the capacity of virtually any laboratory.

It is not intended that each requirement be taken as necessitating proof by a single test. Rather, it is intended that any agency proposing to conduct tests to this International Standard certify that if a particular test could be and were to be carried out then their equipment would meet the requirements. This certification would be based on reasonable deductions from existing data, such as the results of partial tests. The agency would normally be expected to make the basis of their certification available to users of their test results.

The basis of certification of some subjects can be very direct, in that a single test can demonstrate compliance. For others, a less direct form of certification will be necessary. To continue with the above example, the agency could have obtained similar calibrations with direct current at a medium frequency and, from knowledge of the transducer, might infer that calibrations at intermediate frequencies would have been the same.

Similar considerations apply to the practical need to divide the whole channel into subsystems, for calibration and checking purposes. The requirements are valid only for the whole channel, as this is the sole route by which subsystem performance affects the output quality. If it is difficult to measure the whole channel performance, which is often the case, the test agency may treat the channel as two or more convenient subsystems. The whole channel will be certified on the basis of subsystem results, together with a rationale for combining them.

To summarize, this International Standard enables users of impact test results to call up a set of relevant instrumentation requirements by merely specifying ISO 6487. Their test agency then has the primary responsibility for certifying that the ISO 6487 requirements are met by their instrumentation system. The evidence on which they have based this certification will be available to the user on request. In this way, fixed requirements, guaranteeing the suitability of the instrumentation for impact testing, can be combined with flexible methods of demonstrating compliance with those requirements.

Road vehicles — Measurement techniques in impact tests — Instrumentation

1 Scope

This International Standard gives requirements and recommendations for measurement techniques involving the instrumentation used in impact tests carried out on road vehicles. Its requirements are aimed at facilitating comparisons between results obtained by different testing laboratories, while its recommendations will assist such laboratories in meeting those requirements. It is applicable to instrumentation including that used in the impact testing of vehicle subassemblies. It does not include optical methods, which are the subject of ISO 8721.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2041:1990, *Vibration and shock — Vocabulary*

ISO 3784, *Road vehicles — Measurement of impact velocity in collision tests*

ISO 4130, *Road vehicles — Three-dimensional reference system and fiducial marks — Definitions*

SAE J211/1, *Instrumentation for impact test — Part 1: Electronic instrumentation*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 2041 and the following apply.

3.1
data channel
all the instrumentation from, and including, a single transducer (or multiple transducers, the outputs of which are combined in some specified way) to, and including, any analysis procedures that may alter the frequency content or the amplitude content of data

3.2
transducer
first device in a data channel used to convert a physical quantity to be measured into a second quantity (such as an electrical voltage), which can be processed by the remainder of the channel

3.3
channel amplitude class
CAC
designation for a data channel that meets certain amplitude characteristics as specified by this International Standard

NOTE The CAC number is numerically equal to the upper limit of the measurement range.

3.4
channel frequency class
CFC
frequency class designated by a number indicating that the channel frequency response lies within limits specified by Figure 1 for CFCs 1 000 and 600, or is filtered using the algorithm given in annex A

NOTE This number and the value of the frequency F_H (see Figure 1), in hertz, are numerically equal.

3.5
calibration value
mean value measured and read during calibration of a data channel

3.6
sensitivity
ratio of the output signal (in equivalent physical units) to the input signal (physical excitation) when an excitation is applied to the transducer

EXAMPLE 10,24 mV:g/V for a strain gauge accelerometer.

3.7
sensitivity coefficient
slope of the straight line representing the best fit to the calibration values, determined by the method of least squares within the channel amplitude class

3.8
calibration factor of a data channel
mean value of the sensitivity coefficients evaluated over frequencies evenly spaced on a logarithmic scale between F_L and F_H/2,5

3.9
linearity error
ratio of the maximum difference between the calibration value and the corresponding value read on the straight line at the upper limit of the channel amplitude class

NOTE It is expressed as a percentage.

See 4.6.

3.10
transverse sensitivity of a rectilinear transducer
sensitivity to excitation in a nominal direction perpendicular to its sensitive axis

NOTE 1 The transverse sensitivity of a rectilinear transducer is usually a function of the nominal direction of the axis chosen.

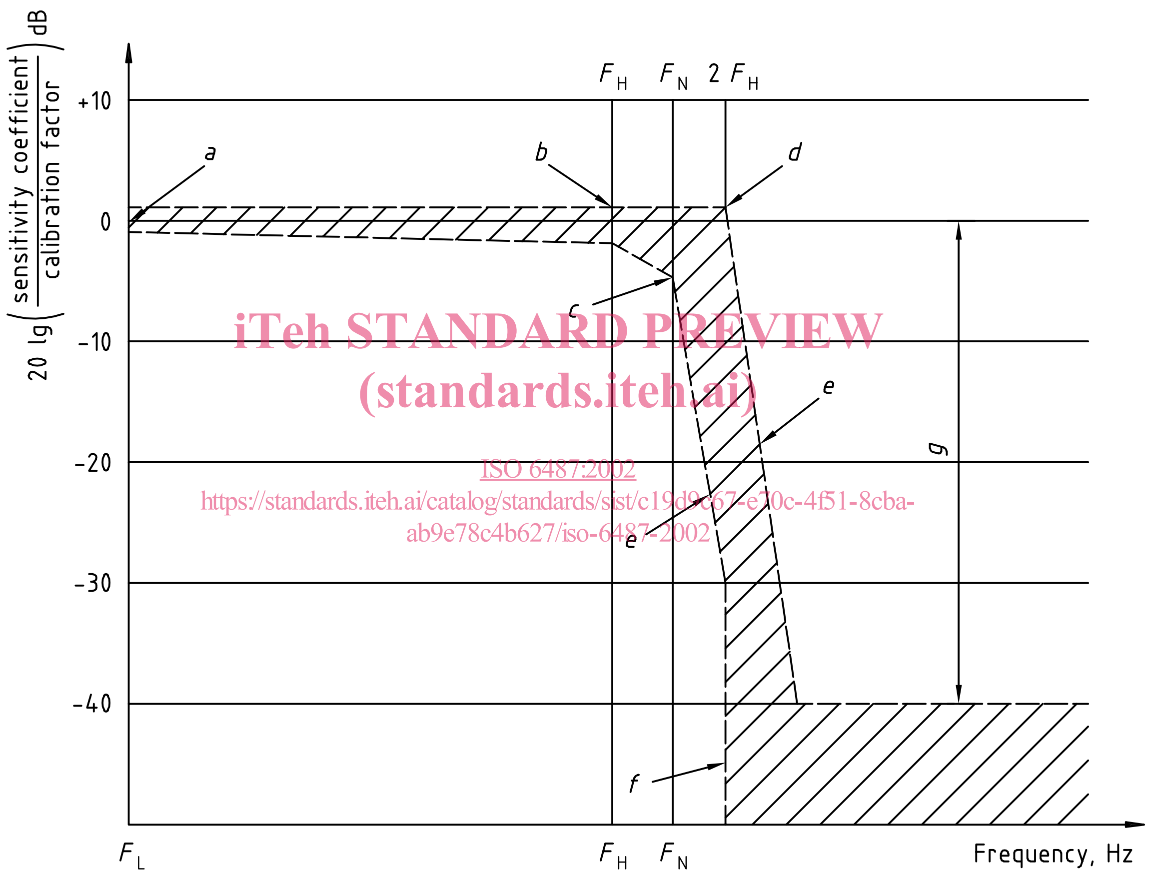
NOTE 2 The cross sensitivity of force and bending moment transducers is complicated by the complexity of loading cases. At time of publication, this situation had yet to be resolved.

3.11
transverse sensitivity ratio of a rectilinear transducer
ratio of the transverse sensitivity of a rectilinear transducer to its sensitivity along its sensitive axis

NOTE The cross sensitivity of force and bending moment transducers is complicated by the complexity of loading cases. At time of publication, this situation had yet to be resolved.

3.12
phase delay time of a data channel
time equal to the phase delay, expressed in radians, of a sinusoidal signal, divided by the angular frequency of that signal, and expressed in radians per second

3.13
environment
aggregate, at a given moment, of all external conditions and influences to which the data channel is subject



Logarithmic scale	
a	± 0,5 dB
b	+ 0,5; – 1 dB
c	+ 0,5; – 4 dB
d	+ 0,5 dB
e	– 24 dB/octave
f	– ∞
g	– 40 dB

CFC	F_L Hz	F_H Hz	F_N Hz
1 000	⩽ 0,1	1 000	1 650
600	⩽ 0,1	600	1 000

Figure 1 — Frequency response limits — CFC 1000 and CFC 600

4 Performance requirements

4.1 Linearity error

The absolute value of the linearity error of a data channel at any frequency in the CFC (channel frequency class) shall be less than or equal to 2,5 % of the value of the CAC over the whole measurement range.

4.2 Amplitude against frequency

The frequency response of a data channel shall lie within the limiting curves given in Figure 1 for CFCs 1 000 and 600. For CFCs 180 and 60, the frequency response of the channel is determined by the filter algorithm given in annex A. The zero decibels line is defined by the calibration factor. For CFCs 180 and 60, the frequency response of the data channel shall remain within 0,5 dB of the zero decibel line at frequencies ranging from 0,1 Hz to the CFC, before the digital filter is applied.

See 4.6.2.3.2.

4.3 Phase delay time of a data channel

The phase delay time of a data channel between its input and output shall be determined; it shall not vary by more than 1/10 F_H s between 0,03 F_H and F_H.

4.4 Time

4.4.1 Timebase

A timebase shall be recorded that shall give at least 0,01 s with an accuracy of 1 %.

4.4.2 Relative time delay

The relative time delay between the signals of two or more data channels, regardless of their frequency class, shall not exceed 1 ms, excluding phase delay caused by phase shift. Two or more data channels whose signals are combined shall have the same frequency class and shall have a relative time delay not greater than 1/10 F_H s.

This requirement is applicable to analog signals, synchronization pulses and digital signals.

4.5 Transducer transverse sensitivity ratio of a rectilinear transducer

The transducer transverse sensitivity ratio of a rectilinear transducer shall be less than 5 % in any direction.

4.6 Calibration

4.6.1 General

A data channel shall be calibrated at least once a year against reference equipment traceable to known standards. The methods used to carry out a comparison with reference equipment shall not cause an error greater than 1 % of the CAC. The use of reference equipment is limited to the range of frequencies for which it has been calibrated.

Data channel subsystems may be evaluated individually and the results factored into the accuracy of the total data channel. This can be made, for example, by an electrical signal of known amplitude simulating the output signal of the transducer, allowing a check to be made on the gain of the data channel, excluding the transducer.

4.6.2 Accuracy of reference equipment for calibration

4.6.2.1 General

The accuracy of the reference equipment shall be certified or endorsed by an approved metrology service.

4.6.2.2 Static calibration

4.6.2.2.1 Acceleration

The error shall be less than 1,5% of the channel amplitude class.

4.6.2.2.2 Force and displacement

The error shall be less than 1 % of the channel amplitude class.

4.6.2.3 Dynamic calibration

4.6.2.3.1 Acceleration

The error in the reference accelerations expressed as a percentage of the channel amplitude class shall be less than 1,5 % at below 400 Hz, less than 2 % between 400 Hz and 900 Hz, and less than 2,5 % between 900 Hz and the maximum frequency at which the reference acceleration is used (see 4.6.4).

4.6.2.3.2 Forces and displacements

A method for the evaluation of the dynamic response during the calibration of data channels for forces and displacements has not been included in this International Standard, since no satisfactory method is known at present. The problem is to be reconsidered at a later date.

4.6.2.4 Time

The relative error in the reference time shall be less than 10^{-5}.

4.6.3 Sensitivity coefficient and linearity error

The sensitivity coefficient and the linearity error shall be determined by measuring the output signal of the data channel against a known input signal, for various values of this signal.

The calibration of the data channel shall cover the whole range of the amplitude class.

For bi-directional channels, both the positive and negative values shall be used.

If the calibration equipment cannot produce the required input, due to the excessively high values of the quantity to be measured, calibrations shall be carried out within the limits of these calibration standards, and these limits shall be recorded in the report.

A total data channel shall be calibrated at a frequency or at spectrum of frequencies, with its significant value being between F_L and $F_H/2,5$.

4.6.4 Calibration of frequency response

The response curves of phase and amplitude against frequency shall be determined by measuring the output signals of the data channel in terms of phase and amplitude against a known input signal, for various values of this signal varying between F_L and ten times the CFC or 3 000 Hz, whichever is the lower.