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Road vehicles — Vehicle dynamics test methods —

Part 1:
General conditions for passenger cars

Véhicules routiers — Méthodes d'essai de la dynamique des véhicules —

Partie 1: Conditions générales pour voitures particulières

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 33, *Vehicle dynamics and chassis components*.

This third edition cancels and replaces the second edition (ISO 15037-1:2006), which has been technically revised. The main changes compared to the previous edition are as follows:

— Recognizing regenerative braking and active control systems.

This corrected version of ISO 15037-1:2019 incorporates the following corrections:

— the date has been corrected to 2019 in the headers and footers.

A list of all parts in the ISO 15037 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document was developed to define general test conditions for vehicle dynamic tests. Any given vehicle, together with its driver and the prevailing environment, constitutes a unique closed-loop system. The task of evaluating the dynamic behaviour of the vehicle is therefore very difficult since there is significant interaction between these driver-vehicle-environment elements, and each of these elements is individually complex in itself.

The test conditions exert large influence on the test results. Only test results obtained at identical test conditions are comparable.

Road vehicles — Vehicle dynamics test methods —

Part 1:
General conditions for passenger cars

1 Scope

This document specifies the general conditions that apply when vehicle dynamics properties are determined according to ISO test methods.

In particular, it specifies general conditions for:

— variables;

— measuring equipment and data processing;

— environment (test track and wind velocity);

— test vehicle preparation (tuning and loading);

— initial driving; and

— test reports (general data and test conditions).

These items are of general significance, regardless of the specific vehicle dynamics test method. They apply when vehicle dynamics properties are determined, unless other conditions are required by the standard which is actually used for the test method.

This document is applicable to passenger cars as defined in ISO 3833 and light trucks.

NOTE The general conditions defined in existing vehicle dynamics standards are valid until a reference to this document is included.

This document is cited in many other standards without a dated reference. In the course of its revision, no change in the numbering of clauses, tables and figures is anticipated.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1176, *Road vehicles — Masses — Vocabulary and codes*

ISO 2416, *Passenger cars — Mass distribution*

ISO 3833, *Road vehicles — Types — Terms and definitions*

ISO 8855, *Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8855 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Variables

4.1 Reference system

The variables of motion used to describe vehicle behaviour in a test-specific driving situation relate to the intermediate axis system (X, Y, Z) (see ISO 8855).

The location of the origin of the vehicle axis system (X_V, Y_V, Z_V) is the reference point, and this position shall be reported (see Annex A).

NOTE Useful positions for the reference point include (1) the centre of gravity of the vehicle and (2) a fixed point of geometry such as the point in the longitudinal plane of symmetry at the height of the centre of gravity and at mid-wheelbase. Locating the reference point at the centre of gravity is very useful for analytical evaluation of the test results of individual vehicles, but can cause difficulty in comparing results for different vehicles. Locating the reference point at the geometrical position is more convenient for comparing results from different tests, but can complicate theoretical analysis.

4.2 Variables to be determined

To describe the vehicle dynamics in terms of driver input and vehicle response, the principal relevant variables are the following:

— steering-wheel angle (δ_H);

— steering-wheel torque (M_H);

— longitudinal velocity (v_X);

— sideslip angle (β) or lateral velocity (v_Y);

— longitudinal acceleration (a_X);

— lateral acceleration (a_Y);

— yaw velocity ($\mathrm{d}\psi/\mathrm{d}t$);

— roll velocity ($\mathrm{d}\varphi/\mathrm{d}t$);

— pitch velocity ($\mathrm{d}\theta/\mathrm{d}t$);

— roll angle (φ);

— pitch angle (θ).

These variables are defined in ISO 8855.

All standards that make reference to this document shall specify which variables apply. Depending on the specific standard, additional variables can be required or recommended.

NOTE These variables can be determined directly by measuring or by calculation from measured values.

5 Measuring equipment

5.1 Description

Time histories of the measured variables shall be recorded by a time-based multi-channel recording system by means of appropriate transducers (see Annex C). Typical operating ranges and recommended maximum errors of the transducer and recording system are shown in Table 1. The specified accuracies should be achieved whether the variables are measured or are calculated.

Table 1 — Variables, their typical operating ranges and recommended maximum errors

Variable	Typical operating range	Recommended maximum "overall" error
Steering-wheel angle	−360° to 360°	±1° for δ_H < 50° ±2° for δ_H > 50° and < 180° ±4° for δ_H > 180°
Steering-wheel torque	−30 Nm to 30 Nm	±0,1 Nm for M_H < 10 Nm ±0,3 Nm for M_H > 10 Nm
Longitudinal velocity	0 km/h to 180 km/h	±1 km/h for v_X < 100 km/h ±2 km/h for v_X > 100 km/h
Lateral velocity	−10 m/s to 10 m/s	±0,2 m/s
Sideslip angle	−20° to 20°	±0,3°
Longitudinal acceleration	−15 m/s² to 15 m/s²	±0,15 m/s²
Lateral acceleration	−15 m/s² to 15 m/s²	±0,15 m/s²
Yaw velocity	−50°/s to 50°/s	±0,3°/s for dψ/dt < 20°/s ±1°/s for dψ/dt > 20°/s
Pitch velocity	−50°/s to 50°/s	±0,3°/s for dθ/dt < 20°/s ±1°/s for dθ/dt > 20°/s
Roll velocity	−50°/s to 50°/s	±0,3°/s for dφ/dt < 20°/s ±1°/s for dφ/dt > 20°/s
Roll angle	−15° to 15°	±0,15°
Pitch angle	−15° to 15°	±0,15°

Increased measurement accuracy may be desirable for computation of some of the characteristic values. If any system error exceeds the recommended maximum value, this and the actual maximum error shall be stated in the test report (see Annex A).

5.2 Transducer installations

The transducers shall be installed according to the manufacturer's instructions when such instructions exist, so that the variables corresponding to the terms and definitions of ISO 8855 can be determined.

If a transducer does not measure a variable in the defined position, appropriate transformation shall be carried out.

5.3 Data processing

5.3.1 General

The frequency range relevant for tests on horizontal dynamics of passenger cars is between 0 Hz and the maximum utilized frequency: f_{max} = 5 Hz. Based on whether analogue or digital data processing methods are used, the requirements given in 5.3.2 or in 5.3.3 apply.

5.3.2 Analogue data processing

The bandwidth of the entire, combined transducer/recording system shall be no less than 8 Hz.

In order to execute the necessary filtering of signals, low-pass filters shall be employed. The width of the passband (from 0 Hz to frequency f_0 at −3 dB) shall not be less than 9 Hz. Amplitude errors shall be less than ±0,5 % in the relevant frequency range of 0 Hz to 5 Hz. All analogue signals shall be processed with filters having sufficiently similar phase characteristics to ensure that time delay differences due to filtering lie within the required accuracy for time measurement.

NOTE During analogue filtering of signals with different frequency contents, phase shifts can occur. Therefore, a digital data processing method, as described in 5.3.3, is preferable.

5.3.3 Digital data processing

5.3.3.1 General considerations

Preparation of analogue signals includes consideration of filter amplitude attenuation and sampling rate to avoid aliasing errors, and filter phase lags and time delays. Sampling and digitizing considerations include pre-sampling amplification of signals to minimize digitizing errors; number of bits per sample; number of samples per cycle; sample and hold amplifiers; and timewise spacing of samples. Considerations for additional phaseless digital filtering include the selection of passbands and stopbands and the attenuation and allowable ripple in each; and correction of filter phase lags. Each of these factors shall be considered in order to achieve a relative overall data acquisition accuracy of ±0,5 %.

Attenuation and phase shift information for a Butterworth filter is provided in Annex D.

5.3.3.2 Aliasing errors and anti-aliasing filters

In order to avoid uncorrectable aliasing errors, the analogue signals shall be appropriately filtered before sampling and digitizing. The order of the filters used and their passband shall be chosen according to both the required flatness in the relevant frequency range and the sampling rate.

The minimum filter characteristics and sampling rate shall be such that:

a) within the relevant frequency range of 0 Hz to f_{max} = 5 Hz, the maximum attenuation of the analogue signal is less than the resolution of the digitized signal;

b) at one-half the sampling rate (i.e. the Nyquist or “folding” frequency), the magnitudes of all frequency components of signal and noise are reduced to less than the digital resolution.

For 0,05 % resolution, the filter attenuation shall be less than 0,05 % to 5 Hz, and the attenuation shall be greater than 99,95 % at all frequencies greater than one-half the sampling frequency.

It is recommended that anti-aliasing filters be of order four or higher (see Annex D).

Although filtering for anti-aliasing is required, excessive analogue filtering shall be avoided. Moreover, all filters shall have sufficiently similar phase characteristics to ensure that differences in time delays between signals are compatible with the required accuracy for the time measurement.

NOTE Phase shifts are especially significant when measured variables are multiplied together to form new variables, because, while amplitudes multiply, phase shifts and associated time delays add up. Phase shifts and time delays are reduced by increasing the filter cut-off frequency, f_0. Whenever formulae describing the pre-sampling filters are known, it is practical to remove their phase shifts and time delays by simple algorithms performed in the frequency domain.

5.3.3.3 Data sampling and digitizing

At 5 Hz, the signal amplitude changes by up to 3 % per millisecond. To limit dynamic errors caused by changing analogue inputs to 0,1 %, sampling or digitizing time shall be less than 32 µs. Each pair or set of data samples to be compared shall be taken simultaneously or within a sufficiently short time period.

