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Road vehicles — Vehicle dynamics test methods —

Part 2:
General conditions for heavy vehicles and buses

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

Partie 2: Conditions générales pour véhicules lourds et autobus

Reference number
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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 15037-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 9, *Vehicle dynamics and road-holding ability*.

ISO 15037 consists of the following parts, under the general title *Road vehicles — Vehicle dynamics test methods*:

— *Part 1: General conditions for passenger cars*

— *Part 2: General conditions for heavy vehicles and buses*

Introduction

The dynamic behaviour of heavy vehicles is a most important part of active vehicle safety. Any given vehicle, together with its driver and the prevailing environment, constitutes a closed-loop system which is unique. 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. Each of these elements is individually complex in themselves.

Moreover, the knowledge of the relationship between overall vehicle dynamic properties and accident avoidance is insufficient. The number of variants of heavy vehicles is enormous and each vehicle is itself unique. Therefore, the measured results are valid only for the actual vehicle tested, and the application of results to other, apparently similar, vehicles is not permissible.

Test conditions have a strong influence on test results. Only vehicle dynamic properties obtained under virtually identical test conditions are comparable.

Road vehicles — Vehicle dynamics test methods —

Part 2:
General conditions for heavy vehicles and buses

1 Scope

This part of ISO 15037 specifies the general conditions that apply when vehicle dynamics properties are determined according to ISO test methods carried out on heavy vehicles. These are commercial vehicles, combinations, buses and articulated buses, as defined in ISO 3833 for trucks and trailers above 3,5 t and buses above 5 t maximum weight, and in UNECE (United Nations Economic Commission for Europe) and EC vehicle classification, categories M3, N2, N3, O3 and O4.

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 reporting (general data and test conditions),

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

NOTE The general conditions defined in existing vehicle dynamics standards are valid up until the point when a respective reference to this part of ISO 15037 is included.

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 1176:1990, *Road vehicles — Masses — Vocabulary and codes*

ISO 3833:1977, *Road vehicles — Types — Terms and definitions*

ISO 8855:1991, *Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary*

UNECE Regulation No. 13, *Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking* (Series 09: 28 August 1996 and supplements 1 to 4: 4 February 1999)

UNECE Regulation No. 30, *Uniform provisions concerning the approval of pneumatic tyres for motor vehicles and their trailers*

3 Terms and definitions

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

3.1
vehicle unit
unit of vehicle combination connected with a yaw-articulation joint

EXAMPLE Tractor, semitrailer or dolly.

NOTE The number of vehicle units is one more than the number of articulation joints.

3.2
offtracking
lateral deviation between the path of the centre-line point of the front axle of the vehicle and the path of the centre-line point of some other part of the vehicle

NOTE 1 If a single number is given, it becomes the maximum offtracking.

NOTE 2 In a single-lane-change manoeuvre where the path of the other part is farther from the projection of the original path of the vehicle than the path of the front axle, the path of the other part is said to “overshoot” the path of the front axle at that point. In the opposite case, the path of the other part is said to “undershoot” the path of the front axle.

3.3
rearward amplification
ratio of the maximum value of the motion variable of interest (e.g. lateral acceleration or yaw velocity) of a following vehicle unit to that of the first vehicle unit during a specified manœuvre

3.4
zero damping speed
speed at which the damping coefficient of the free oscillatory yaw movements of the vehicle combination equals zero

3.5
reference damping speed
speed at which the damping coefficient of the free oscillatory yaw movements of the vehicle combination equals 0,05

3.6
centre-line point
point at the intersection of the ground plane and the x–z plane of symmetry of the part of interest, which point lies directly below a longitudinal reference position

NOTE For an axle, the longitudinal reference point is the wheel-spin axis. For other parts, the longitudinal reference point needs to be stated.

3.7
yaw articulation angle
yaw angle of the X axis of the intermediate axis system of a more forward vehicle unit in the intermediate axis system of a following vehicle unit, i.e. the angle between the X axes of the two units, with polarity determined by the rotation of the leading unit in the axis system of the following unit

NOTE The units involved are usually adjacent, but not necessarily so.

4 Variables

4.1 Reference system

The variables of motion used to describe the 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 intermediate axis system of a vehicle unit is the reference point for that unit. The location is at ground level in the plane of symmetry at the longitudinal position of the rearmost non-lifting axle of the unit.

4.2 Variables to be measured

To describe the horizontal dynamics of a vehicle or vehicle–driver system, the following variables are relevant (but are not intended to comprise a complete list):

— lateral acceleration of each vehicle unit (a_Y);

— roll angle of each vehicle unit at relevant points (φ);

— sideslip angle of each vehicle unit (β);

— articulation angle ($\Delta\psi$);

— wheel load (F_Z);

— yaw velocity of each vehicle unit ($\dot{\Psi}$);

— longitudinal velocity (v_X);

— offtracking of points of interest (Δ_r);

— longitudinal acceleration (a_X);

— steering wheel angle (δ_H);

— steering wheel torque ($M_{\Delta \mathrm{H}}$).

These variables are defined in this part of ISO 15037 or in ISO 8855. All standards that make reference to this part of ISO 15037 shall specify which variables apply.

5 Measuring equipment

5.1 Description

All variables shall be measured by means of appropriate transducers and their time histories shall be recorded by a multi-channel recording system. Typical operating ranges and recommended maximum errors of the transducer and recording system are given in Table 1.

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

Variable	Typical operating range	Recommended maximum error of combined system
Steering wheel angle	± 360°	± 2° for angles < 180°
		± 4° for angles > 180°
Longitudinal velocity	0 to 35 m/s	± 0,3 m/s
Lateral acceleration	± 15 m/s^2	± 0,15 m/s^2
Articulation angle between vehicle units	± 50°	± 0,5°
Yaw velocity of each vehicle unit	± 50°/s	± 0,5°/s
Lateral displacement of points of interest	± 10 m	± 0,05 m
Wheel load	0 to rated axle load	± 2 % of full scale
Roll angle of each vehicle unit at relevant points	± 15°	± 0,2°
Lateral velocity	± 10 m/s	± 0,2 m/s
Sideslip angle of each vehicle unit	± 10°	± 0,5°
Articulation angular velocity	± 50°/s	± 0,5°/s
Steering wheel torque in case of no power steering	± 50 Nm	± 0,5 Nm
Steering wheel torque in case of power steering	± 20 Nm	± 0,2 Nm
Longitudinal acceleration	± 15 m/s^2	± 0,15 m/s^2

5.2 Transducer installations

The transducers shall be installed according to the manufacturer's instructions, where 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 directly, appropriate transformations shall be carried out.

5.3 Data processing

5.3.1 General

The frequency range relevant for tests on horizontal dynamics of heavy vehicles is between 0 Hz and the maximum utilized frequency f_{max} = 2 Hz. Depending on the chosen data-processing method (analog or digital data processing), the provisions of 5.3.2 or 5.3.3 are to be observed.

For lighter trucks it could be necessary to increase f_{max} to 3 Hz, in which case the following requirements concerning the frequency f_{max} may be modified correspondingly.

5.3.2 Analog 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 of order 4 or higher 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 2 Hz. All analog signals shall be processed with filters having phase characteristics sufficiently similar to ensure that time delay differences due to filtering lie within the required accuracy for time measurement.

NOTE During analog filtering of signals with different frequency contents, phase shifts can occur. Because of this, a digital data processing method such as that given in 5.3.3 is preferable.

5.3.3 Digital data processing

5.3.3.1 General considerations

Preparation of analog 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 presampling amplification of signals to minimize digitization errors, number of bits per sample, number of samples per cycle, sample and hold amplification, and timewise spacing of samples. Considerations for additional phaseless digital filtering include selection of passbands and stopbands, and the attenuation and allowable ripple in each, as well as correction of antialias filter phase lags. Each of these factors must be considered if an overall data acquisition accuracy of ± 0,5 % is to be achieved.

5.3.3.2 Aliasing errors

In order to avoid aliasing errors that cannot be corrected, the analog 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} = 2 Hz the attenuation is less than the resolution of the data acquisition system, and

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 system resolution.

For 12-bit data acquisition systems with a resolution of 0,05 %, the filter attenuation shall be less than 0,05 % to 2 Hz and the attenuation shall be greater than 99,95 % at all frequencies greater than one-half the sampling frequency.

NOTE For a Butterworth filter, the attenuation is given by

$$A^2 = \frac{1}{1 + \left(\frac{f}{f_0}\right)^{2n}}$$

where

n is the order of filter;

f_0 is the filter cut-off frequency.

The above is such that

$A / f - f_{max} \geqslant$ 0,999 5, and

$A / f - f_N \leqslant$ 0,000 5

where

f_{max} is the highest frequency (2 Hz) in the relevant frequency range;

f_N is the Nyquist or “folding” frequency;

f_s is the sampling frequency = $2 \times f_N$.

For a fourth-order filter:

for A = 0,999 5, f_0 = 2,37 × f_{max} = 4,74 Hz;

for A = 0,000 5, f_s = 2 × (6,69 × f_0) = 63 Hz.

5.3.3.3 Filter phase shifts and time delays for antialiasing filtering

Excessive analog filtering shall be avoided and all filters shall have sufficiently similar phase characteristics such that time delay differences lie within the required accuracy for the time measurement.

Phase shifts are especially significant when measured variables are multiplied together to form new variables. This is because while amplitudes multiply, phase shifts and associated time delays add. Phase shifts and time delays are reduced by increasing f_0. Whenever equations describing the presampling filters are known, it is practical to remove their phase shifts and time delays by simple algorithms performed in the frequency domain.

NOTE In the frequency range in which the filter amplitude characteristics remain flat, the phase shift Φ of a Butterworth filter can be approximated by

$\Phi = 81 \times (f/f_0)°$ for 2nd order,

$\Phi = 150 \times (f/f_0)°$ for 4th order, and

$\Phi = 294 \times (f/f_0)°$ for 8th order.

The time delay for all filter orders is $t = (\Phi/360°) \times (1/f_0)$.

5.3.3.4 Data sampling and digitization

At 2 Hz the signal amplitude changes by up to 1,25 % per millisecond. To limit dynamic errors caused by changing analog inputs to 0,1 %, the sampling or digitizing time shall be less than 80×10^{-6} s. All pairs or sets of data samples to be compared shall be taken simultaneously or over a sufficiently short time period.

In order not to exceed an amplitude error of 0,5 % in the relevant frequency range 0 to f_{max}, the sampling rate shall be at least 30 f_{max}.

5.3.3.5 System requirements

The data acquisition system shall have a minimum resolution of 12 bits (± 0,05 %) and an accuracy of 2 LSB (± 0,1 %). Antialiasing filters shall be of order 4 or higher and the relevant frequency range shall be 0 Hz to f_{max}.

For fourth-order filters, the filter cut-off frequency, f_0, shall be greater than 2,37 × f_{max} if phase errors are subsequently adjusted in digital data processing, and greater than 5 × f_{max} otherwise; the data sampling frequency f_s shall be greater than 13,4 × f_0.

For filters other than fourth-order filters, f_0 and f_s shall be selected for adequate flatness and alias error prevention.

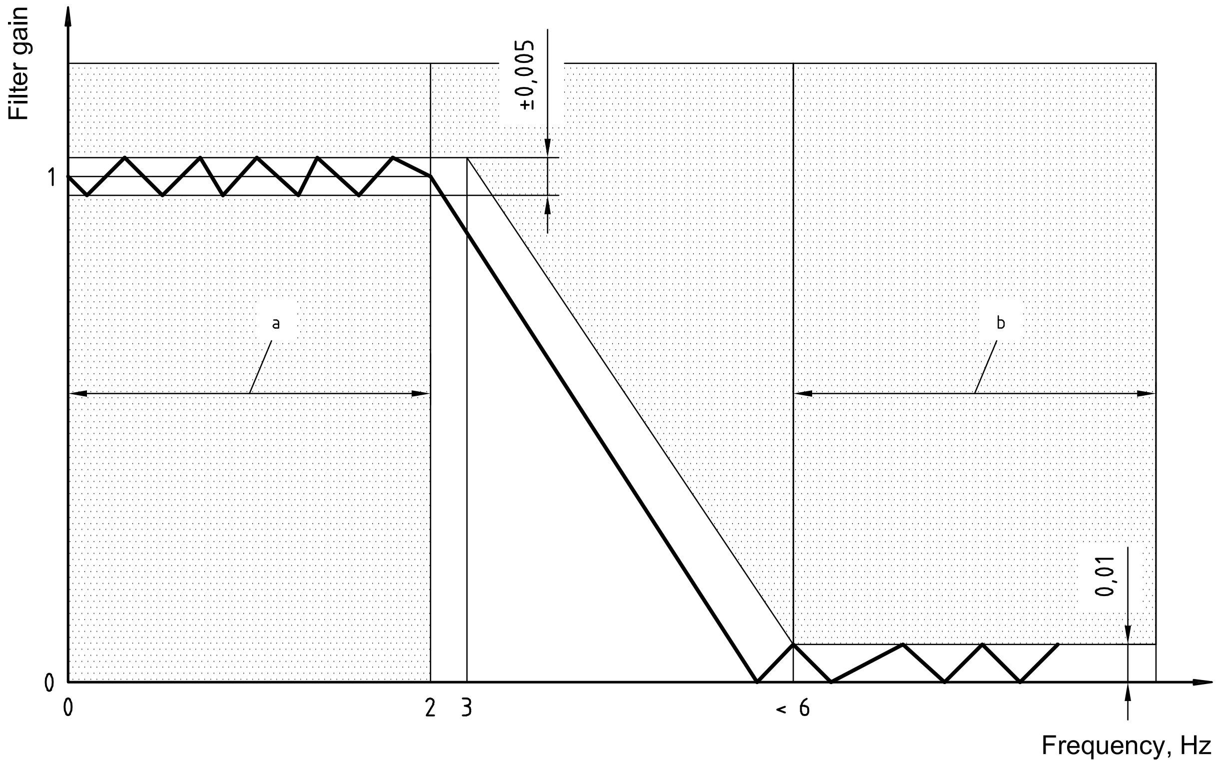
Amplification of the signal before digitization shall be such that during the digitization process, the additional error will be less than 0,2 %.

Sampling or digitizing time for each data channel sampled shall be less than 80×10^{-6} s.

5.3.3.6 Digital filtering

For filtering of sampled data in data evaluation, phaseless (zero-phase-shift) digital filters incorporating the following characteristics shall be used (see Figure 1):

- passband range of from 0 Hz to 2 Hz;
- stopband beginning at less than 6 Hz;
- filter gain in passband of 1 ± 0,005 (100 ± 0,5 %);
- filter gain in stopband of < 0,01 (< 1 %);
- filter gain falling within the unshaded area of Figure 1.



a Passband
b Stopband

Figure 1 — Required characteristics of phaseless digital filters

6 Test conditions

6.1 General

Limits and specifications for test track, ambient conditions and vehicle test conditions are established in the following subclauses; these limits and specifications shall be maintained throughout the specific test. Any deviations shall be shown in the test report (see Annexes A and B) including the individual diagrams of the presentation of results. For each test procedure, the test-specific conditions and those which cannot be kept constant (e.g. tread depths) shall be recorded in a separate test report in accordance with Annex B.

6.2 Test track

All standard tests shall be carried out on a smooth, clean, dry and uniform paved road surface. The gradient of this surface to be used shall not exceed 2,5 % in any direction when measured over any distance greater than or equal to the vehicle track. In addition, for tests concerned with damping of combination vehicles, the gradient shall not exceed 1 % along the path of the vehicle as measured over any distance of 25 m or more. For each test the road surface conditions and paving material shall be recorded in the test report (see Annex B).

6.3 Ambient conditions

The ambient wind velocity shall not exceed 5 m/s during a test. For each test method the climate conditions shall be recorded in the test report (see Annex B).

Since, in certain cases, ambient temperature has a significant influence on test results, it should be taken into account when making comparisons between vehicles.

6.4 Test vehicle

6.4.1 General data

General data of the test vehicle or vehicle unit shall be presented in the test report in accordance with Annex A.

6.4.2 Tyres

For a standard test condition, new tyres shall be fitted on the test vehicle according to the vehicle manufacturer's specifications. If not specified by the tyre manufacturer, they shall be run in for at least 150 km on the test vehicle or an equivalent vehicle without excessively harsh use (severe braking, acceleration, cornering, hitting the kerb, etc.). After run-in, the tyres shall be maintained at the same position on the vehicle for the tests.

Tyres shall have a tread depth of at least 90 % of the original values in the principal grooves within 3/4 of the tread breadth, in accordance with the treadwear indicator specifications of UNECE Regulation 30.

Tyres shall have been stored according to the tyre manufacturer's recommendations and shall not have been manufactured more than two years prior to the test. The date of manufacture shall be noted in the presentation of test conditions (see Annex A).

Tyres shall be inflated to the pressure specified by the vehicle manufacturer for the test vehicle configuration. The tolerance for setting the cold inflation pressure is ± 2 %.

The inflation pressure and tread depth of the tyres determined before tyre warm-up and at the completion of the test shall be recorded in the test report (see Annex A).

Tests may also be performed with tyres in any state of wear as well as with retreaded or regrooved tyres. The details shall be noted in the test report (see Annex A). As the tread depth or uneven tread wear could have a significant influence on test results, it is recommended that they be taken into account when making comparisons between vehicles or between tyres.

6.4.3 Operating components

For the standard test conditions, all operating components likely to influence the test results (e.g. shock absorbers, springs and other suspension components and suspension geometry) shall be as specified by the manufacturer. Any deviations from manufacturer specification shall be noted in the presentation of general data (see Annex A).

Levelling systems of the chassis and cabin suspension inappropriately affecting response should be disabled during steady-state and step-input tests.

6.4.4 Vehicle loading conditions

6.4.4.1 General conditions

The manufacturer's maximum design total mass and maximum design axle load, both in accordance with ISO 1176, shall not be exceeded.

The total mass and the centre of gravity position (longitudinal, lateral and vertical) can be expected to influence all test results. Moments of inertia can be expected to influence transient test results. For all tests, it is recommended that the total mass and centre of gravity position in three dimensions be reported for each vehicle unit and that for transient tests the moment of inertia in yaw also be reported. In addition, moments of inertia in pitch and roll, if available, should be reported.

Alternatively, the loading condition of the vehicle shall be described adequately in order to allow these parameters to be reproduced.

Care shall be taken to ensure that the masses, centre of gravity positions and moments of inertia of the test vehicle compare closely to those parameters of the vehicle in normal use.

The resulting wheel loads shall be determined and recorded in the test report.

6.4.4.2 Maximum loading conditions

For the maximum loading condition, the total mass of a fully laden vehicle or combination shall consist of the complete vehicle kerb mass plus the maximum load of interest (e.g. the legal limit), distributed such that none of the maximum axle loads are exceeded. The height of the centre of gravity and the mass distribution of the pay-load should be established to reflect the application of interest. The maximum loading condition is the standard test condition.

6.4.4.3 Minimum loading conditions

The total vehicle mass for each vehicle unit for the minimum loading condition shall consist of the complete vehicle kerb mass plus the mass of the instrumentation. In the case of the first vehicle unit the mass of the driver and, if applicable, the mass of an instrument operator or observer is to be added. The minimum loading condition is optional.

6.4.4.4 Other loading conditions

Other loading conditions representative of special transport conditions are recommended.

7 Test procedure

7.1 Warm-up

All relevant vehicle components shall be warmed up prior to the tests in order to achieve a temperature representative of normal driving conditions.

A procedure equivalent to driving at the test speed for a distance of at least 50 km or 5 000 m at a lateral acceleration of 1 m/s^2 (both left and right turn each) may be appropriate for warming up the tyres.

The tyre pressures after warm-up may be recorded.

7.2 Initial driving condition

7.2.1 General

The initial driving condition is specified in each vehicle dynamics test procedure. It may be either a steady-state, straight-ahead or steady-state circular run.

The position of the transmission lever and the selected driving program shall be recorded in the test report (see Annex A).

The position of the steering wheel and the accelerator pedal shall be kept as constant as possible during the initial driving condition. The moment of observation, t_{ss}, used to evaluate steady state conditions, is defined as the point in time which is usually between 0,5 s and 0,8 s before the reference point in time, t_0, of the specific test procedure. The initial condition is considered to be sufficiently constant if, for the moment of observation t_{ss}, the requirements of 7.2.2 and 7.2.3 are fulfilled (see Figure 2).

NOTE For test procedures used to determine only steady-state values, the moment of observation t_{ss} and the reference point t_0 will be identical.

7.2.2 Steady-state straight-ahead run

For the time interval t_1 to t_2, the mean value of the longitudinal velocity shall not vary from the nominal value by more than ± 3 % and the mean value of lateral acceleration shall be within the range – 0,3 m/s^2 to + 0,3 m/s^2. As an alternative to the limits of lateral acceleration, the mean value of the yaw velocity shall be within the range – 0,5°/s to + 0,5°/s.

For the time interval t_1 to t_2, the standard deviation of the lateral acceleration shall not exceed 0,3 m/s^2 and the standard deviation of the t_1 to t_2 longitudinal velocity shall not exceed 3 % of its mean value. As an alternative to the limits of lateral acceleration, the standard deviation of the yaw velocity shall not exceed 0,5°/s.

The difference between the mean values of the longitudinal velocity during the time intervals t_1 to t_{ss} and t_{ss} to t_2 shall not exceed 3 % of the nominal value.

7.2.3 Steady-state circular run

The initial radius, R_0, may be observed or calculated as follows:

$$R_0 = v_{X,0} / (\mathrm{d}\psi_0/\mathrm{d}t)$$

or

$$R_0 = v_{X,0}^2 / a_{Y,0}$$

The initial radius in the initial driving condition shall not deviate by more than ± 0,5 m at the reference point of the towing vehicle from the nominal value during the time interval t_1 to t_2.

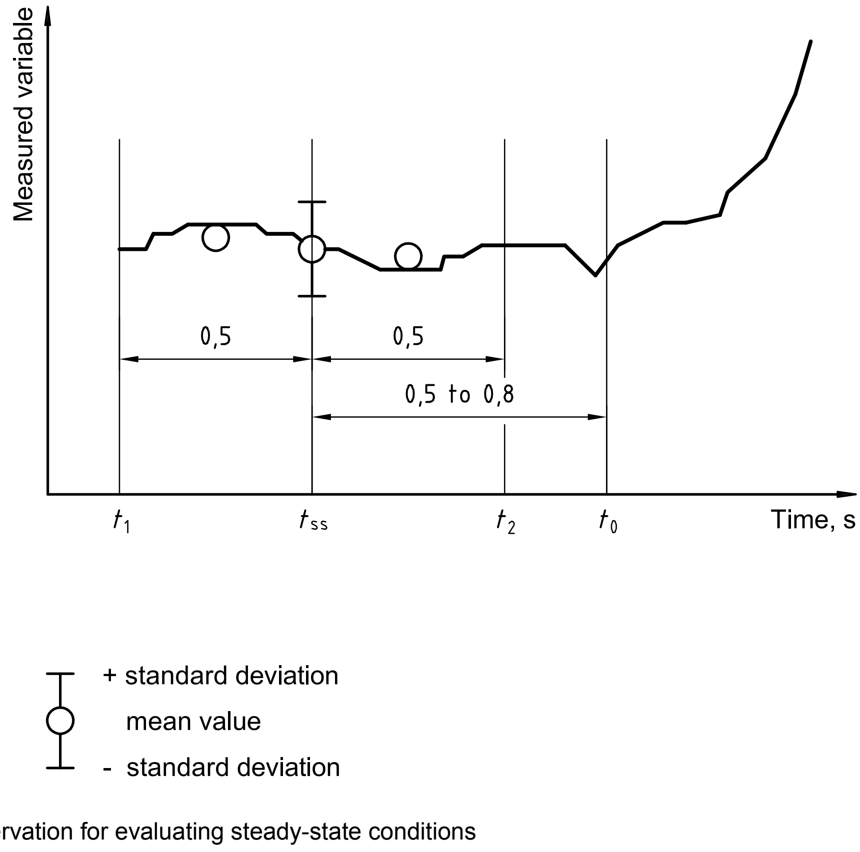
For the time interval t_1 to t_2, the standard deviation of the lateral acceleration shall not exceed 5 % of its mean value and the standard deviation of the longitudinal velocity shall not exceed 3 % of its mean value.

The difference between the mean values during the time intervals t_1 to t_{ss} and t_{ss} to t_2 shall not exceed the nominal value for the lateral acceleration by more than 5 % and the longitudinal velocity by more than 3 %.

For the time interval t_1 to t_2, the mean value of the lateral acceleration shall not deviate from the nominal value by more than ± 3 %.

7.3 Average longitudinal acceleration

For tests concerned with damping of combination vehicles, the average longitudinal acceleration over the time period during which measurements are actually made shall be within ± 0,1 m/s².



t_{ss} Moment of observation for evaluating steady-state conditions

t_0 Reference point in time of the specific test method

Figure 2 — Definition of times

Annex A
(normative)

Test report — General data

Vehicle or vehicle combination type

Vehicle identification Vehicle unit number (if combination)

Type of vehicle: ....

Vehicle identification number: ....

Make, year, model, type: ....

Odometer reading: ....

Engine Identification code

Type of engine: ❑ Spark ignition ❑ Diesel

Maximum power / engine speed ....kW at ....r/min

Maximum torque / engine speed................................Nm at ....r/min

Transmission Identification code ....

Type / Number of forward gears ❑ manual ....gears

❑ automatic ....gears

❑ torque converter

Final drive ratio:............ : 1

Axle 1 (front) Suspension type: ....

Type of axle: ....

Model: ....

Load rating: ....

Stabilizer type: ....

Number of wheels: ....

Track: ....m

Rim size: ....

Tyres Type: ....

Make (retread): ....

Date: ....

Size: ....

Serial numbers: ....

Shock absorbers Type: ....

Identification number: ....

Number: ....

Steering Type: ....

Overall steering ratio: ....

Braking system Brakes: ....

Manufacturer: ....

Type: ....

Model: ....

ABS: ❑ Yes ❑ No

Manufacturer: ....

Type: ....

Model: ....

Type approved according to ....

UNECE category according to ....

Braking characteristics (measured on roller brake tester at static test load):

Axle braking force related to pedal force or pressure at coupling head or first axle at Static test load .... kN/daN (kN/kPa)

Reaction time at the brake actuators with all units coupled, related to the time of full brake control application by the driver measured in accordance with UNECE Regulation 13, Annex 6, paragraphs 2.1 to 2.4, regardless of whether the axle is on a motor vehicle or not .... s

Drive type: ....

Axle *n*: Suspension type: ....

Type of axle: ....

Model: ....

Load rating: ....

Stabilizer type: ....

Number of wheels: ....

Track: .... m

Rim size: ....

Tyres

Type: ....

Make (retread): ....

Date: ....

Size: ....

Serial numbers: ....

Shock absorbers

Type: ....

Identification number: ....

Number: ....

Steering

Type: ....

Overall steering ratio: ....

Braking system

Brakes: ....

Manufacturer: ....

Type: ....

Model: ....

ABS ❑ Yes ❑ No

Manufacturer: ....

Type: ....

Model: ....

Type approved according to ....

UNECE category according to ....

Braking characteristics (measured on roller brake tester at static test load):

Axle braking force related to pedal force or pressure at coupling head or first axle at static test load ....kN/daN (kN/kPa)

Reaction time at the brake actuators with all units coupled, related to the time of full brake control application by the driver measured according to UNECE Regulation 13, Annex 6, paragraph 2.1 to 2.4 regardless of whether the axle is on a motor vehicle or not .... s

Drive type: ....

Tread depth

Dimensions in millimetres

	Axle 1				Axle n			
	Left		Right		Left		Right	
	inner	outer	inner	outer	inner	outer	inner	outer
Original tread depth								
Tread depth before the test								
Tread depth after the test								

Tyre inflation pressure

Pressure in kilopascals

Cold	Axle 1	Axle n......................................
Hot, after warm up	Axle 1	Axle n......................................
Hot, after test	Axle 1	Axle n......................................

Vehicle or unit dimensions

Distances from reference point:

Axle 1 .... m

Axle (n) .... m

Rear coupling .... m

Front coupling .... m

Overall length .... m

Overall width .... m

Overall height at test mass .... m

Height above ground of front coupling (in test condition) .... m

Height above ground of rear coupling (in test condition) .... m

Coupling types

Front ....

Rear ....

Vehicle loading conditions

Vehicle kerb mass

Axle 1: left wheel ....kg right wheel .... kg

Axle n: left wheel(s) ....kg right wheel(s) .... kg

Static vertical force on the front coupling of the vehicle unit ....N

Vehicle mass as tested

Axle 1: left wheel ....kg right wheel .... kg

Axle n: left wheel(s) ....kg right wheel(s) .... kg

Static vertical force on the front coupling of the vehicle unit .... N

Centre of gravity height above ground .... m

Yaw moment of inertia ....kg·m^2

Position of lateral accelerometer:

height above ground .... m

distance to reference point .... m

Description of pay-load ....

Other data (in particular relevant suspension settings):

....

....

....

....

Annex B
(normative)

Test report — Test conditions

Test method	ISO .... Title ....
Proving ground	Name and location: ....
Test Track	Path radius: .... m
	Lateral gradient .... %
	Longitudinal gradient .... %
	Road surface: ....
	type: ....
	condition: ....
	friction condition/method: ....
	surface temperature: .... °C
Ambient condition	Air temperature: .... °C
	Relative humidity: .... %
	Wind speed: .... m/s
	Wind direction relative to direction of travelling while taking measurements........ deg
Test personnel	Driver ....
	Test engineer ....
	Data analyst ....
Date of test	Day: ....
	Hour: from: .... to: ....

General comments:

....

....

....

....

Bibliography

[1] EC Council Directive No. 92/53/EEC Annex II: *Definition of vehicle categories and vehicle types*

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