
**Heavy commercial vehicles and buses —
Open-loop test methods for the
quantification of on-centre handling —
Weave test and transition test**

*Véhicules utilitaires lourds et autobus — Méthode d'essai en boucle
ouverte pour mesurer la tenue de route en ligne — Essai de
changement de trajectoire et essai transitoire*

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 11012:2009

<https://standards.iteh.ai/catalog/standards/sist/0896f1b9-a29b-488e-b60b-7aad52c40d9e/iso-11012-2009>



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 11012:2009

<https://standards.iteh.ai/catalog/standards/sist/0896f1b9-a29b-488e-b60b-7aad52c40d9e/iso-11012-2009>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2009

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction.....	v
1 Scope	1
2 Normative references	1
3 Terms, definitions and symbols	1
3.1 Terms and definitions	1
3.2 Symbols.....	2
4 Principle	2
5 Variables.....	2
5.1 Reference system.....	2
5.2 Variables.....	3
6 Measuring equipment	3
7 Test conditions	4
8 Test procedure.....	4
8.1 General	4
8.2 Warm-up	4
8.3 Initial driving condition	4
8.4 Weave test procedure	4
8.5 Transition test procedure	5
9 Data evaluation and presentation of results.....	5
9.1 General	5
9.2 Time histories	5
9.3 Characteristic values for the weave test.....	6
9.4 Characteristic values for the transition test	8
Annex A (normative) Test report — General data and test conditions	11
Annex B (informative) Calculating the time delay from sinusoidal data	12
Bibliography.....	14

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 11012 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 9, *Vehicle dynamics and road-holding ability*.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO 11012:2009](https://standards.iteh.ai/catalog/standards/sist/0896f1b9-a29b-488e-b60b-7aad52c40d9e/iso-11012-2009)

<https://standards.iteh.ai/catalog/standards/sist/0896f1b9-a29b-488e-b60b-7aad52c40d9e/iso-11012-2009>

Introduction

The main purpose of this International Standard is to provide repeatable and discriminatory test results.

The dynamic behaviour of a road vehicle is a very important aspect of active vehicle safety. Any given vehicle, together with its driver and the prevailing environment, constitutes a closed-loop system that is unique. The task of evaluating the dynamic behaviour is therefore very difficult, since the significant interaction of these driver-vehicle-environment elements are each complex in themselves. A complete and accurate description of the behaviour of the road vehicle must necessarily involve information obtained from a number of different tests.

Since the test method described in this International Standard quantifies only one small part of the complete vehicle handling characteristics, the results of these tests can only be considered significant for a correspondingly small part of the overall dynamic behaviour.

Moreover, insufficient knowledge is available concerning the relationship between overall vehicle dynamic properties and accident avoidance. A substantial amount of work is necessary to acquire sufficient and reliable data on the correlation between accident avoidance and vehicle dynamic properties in general, and the results of these tests in particular. Consequently, any application of the test method described in this International Standard for regulation purposes will require proven correlation between test results and accident statistics.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO 11012:2009](https://standards.iteh.ai/catalog/standards/sist/0896f1b9-a29b-488e-b60b-7aad52c40d9e/iso-11012-2009)

<https://standards.iteh.ai/catalog/standards/sist/0896f1b9-a29b-488e-b60b-7aad52c40d9e/iso-11012-2009>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 11012:2009

<https://standards.iteh.ai/catalog/standards/sist/0896f1b9-a29b-488e-b60b-7aad52c40d9e/iso-11012-2009>

Heavy commercial vehicles and buses — Open-loop test methods for the quantification of on-centre handling — Weave test and transition test

1 Scope

This International Standard describes two open-loop test methods for determining on-centre handling characteristics of a vehicle in response to specific types of steering input under closely controlled test conditions:

- the weave test, and
- the transition test.

This International Standard applies to heavy vehicles, i.e. commercial vehicles, commercial vehicle combinations, buses and articulated buses as defined in ISO 3833 (trucks and trailers with maximum weight above 3,5 tonnes and buses and articulated buses with maximum weight above 5 tonnes, in accordance with ECE and EC vehicle classification, categories M3, N2, N3, O3 and O4).

2 Normative references

[ISO 11012:2009](https://standards.iteh.ai/catalog/standards/sist/0896fb9-a29b-488e-b60b-7ad5264010e/iso-11012-2009)

[https://standards.iteh.ai/catalog/standards/sist/0896fb9-a29b-488e-b60b-](https://standards.iteh.ai/catalog/standards/sist/0896fb9-a29b-488e-b60b-7ad5264010e/iso-11012-2009)

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, *Road vehicles — Masses — Vocabulary and codes*

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

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

ISO 15037-2:2002, *Road vehicles — Vehicle dynamics test methods — Part 2: General conditions for heavy vehicles and buses*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1176, ISO 3833, ISO 8855, ISO 15037-2 and the following apply.

3.1.1

on-centre handling

objective description of the steering feel and steering precision of a vehicle during nominally straight-line driving and in negotiating large-radius bends at high speeds but low lateral accelerations

3.1.2

ordinate deadband

vertical width of the hysteresis loops at an abscissa value of zero

3.1.3

abscissa deadband

horizontal width of the hysteresis loops at an ordinate value of zero

3.1.4

gradient

ratio of the change in the ordinate to a unit change in the abscissa

3.2 Symbols

For the purposes of this document, the symbols given in ISO 8855 and ISO 15037-2 apply.

4 Principle

On-centre handling represents that part of the straight-line directional stability characteristics of the vehicle existing at low levels of lateral acceleration, typically not larger than 1 m/s². On-centre handling is concerned primarily with features that directly influence the driver's steering input, such as steering-system characteristics and tyre characteristics. Thus, test schedules for the evaluation of on-centre handling behaviour seek to minimize other factors that influence the wider aspects of straight-line directional stability, such as disturbance inputs due to ambient winds and road irregularities.

This International Standard defines two test schedules that involve driving the vehicle in a nominally straight line at a constant forward speed:

- the weave test examines the response at the outer edge of the hysteretic region (see 8.4);
- the transition test examines the transition from straight-line driving to the edge of the hysteretic region (see 8.5).

During these tests, driver inputs and vehicle responses are measured and recorded. From the recorded signals, characteristic values are calculated.

5 Variables

5.1 Reference system

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

For the purposes of this International Standard, the location of the reference point shall be in the plane of symmetry and at the longitudinal and vertical position of the wheel centre of the first axle of the first vehicle unit at static load and straight-ahead steering.

NOTE This provision overrides the provision of 15037-2.

5.2 Variables

When using these test methods, the following variables shall be determined for the first vehicle unit:

- a) steering-wheel angle, δ_H ;
- b) steering-wheel torque, M_H ;
- c) yaw velocity, $d\psi/dt$;
- d) longitudinal velocity, v_X ;
- e) lateral acceleration at the reference point, a_Y .

It is also recommended that the following variable be determined:

- steering-wheel angular velocity, $d\delta_H/dt$.

The listed variables are defined in ISO 8855.

In order to acquire a deeper understanding of the vehicle behaviour, it may be desirable to determine motions of various components within the steering system, especially for vehicles with more than one steering axle.

6 Measuring equipment

The measuring equipment shall be in accordance with ISO 15037-2.

Table 1 shows typical operating ranges and recommended maximum errors of the combined transducer and recording system, which are not given in ISO 15037-2.

NOTE It is advisable that care be taken to ensure that friction or inertia added to the system by steering machines or steering transducers does not improperly influence the measurement of steering-wheel torque.

Table 1 — Typical operating ranges and maximum errors of variables not listed in ISO 15037-2

Variable	Typical operating range	Recommended maximum error of combined system
Steering-wheel angle	$\pm 80^\circ$	$\pm 0,5^\circ$
Steering-wheel torque in case of power steering	$\pm 10 \text{ Nm}$	$\pm 0,1 \text{ Nm}$
Yaw velocity	$\pm 10^\circ/\text{s}$	$\pm 0,1^\circ/\text{s}$
Lateral acceleration	$\pm 5 \text{ m/s}^2$	$\pm 0,05 \text{ m/s}^2$
Steering wheel angular velocity	$\pm 100^\circ/\text{s}$	$\pm 1^\circ/\text{s}$

7 Test conditions

Specifications for test conditions shall be in accordance with ISO 15037-2 together with the additional specifications listed below.

- a) The lateral gradient of the test surface should not exceed 1 % over any distance greater than or equal to the vehicle track.
- b) Special attention should be paid to the condition of the tyres, axle alignments and the steering system to ensure that the vehicle does not lead or pull when operating on a level surface.
- c) During a test, the ambient wind velocity shall not exceed 5 m/s when measured at a height above ground of not less than 1 m. Ideally the maximum ambient wind velocity should not exceed 1,5 m/s. If this cannot be achieved, then conditions where there is significant wind gusting should be avoided, i.e. testing should be avoided in conditions where changes in wind velocity exceed a range of 1,5 m/s. In the event that the ambient velocity exceeds 1,5 m/s or the range of gusting exceeds 1,5 m/s or both, the vehicle should be tested in a direction such that the ambient wind is a tail wind.

8 Test procedure

8.1 General

The weave test requires a test track of approximately 1 000 m length and 20 m width for standard test conditions. The transition test requires less length but approximately 40 m width.

The vehicle is driven at a nominally constant longitudinal velocity. The standard test velocity is 80 km/h. Other velocities may be used. The test velocity should preferably be decremented or incremented by steps of 10 km/h. For each test run, the average longitudinal velocity shall be maintained within a tolerance of ± 2 km/h of the selected speed. A deviation of vehicle longitudinal velocity of ± 3 km/h from the selected longitudinal velocity is permissible. In addition, variation in the position of the accelerator pedal shall be kept to a minimum consistent with maintaining vehicle longitudinal velocity within required limits.

It is preferable that the steering inputs for these tests be made with a steering machine.

Details shall be recorded in the test report (see Annex A).

8.2 Warm-up

See ISO 15037-2.

8.3 Initial driving condition

The initial driving condition shall be as described in ISO 15037-2 for the steady-state straight-ahead run. The allowable variations for yaw velocity should be used rather than those for lateral acceleration.

In the time interval, starting no later than time t_1 and ending at time t_2 (see ISO 15037-2:2002, 7.2), the steering wheel shall be held fixed within $\pm 3^\circ$. If possible, the steering wheel should be subject to zero input torque. At time t_0 , the steering input specified in 8.4 and 8.5 shall be applied.

8.4 Weave test procedure

The weave test procedure requires an oscillatory steering input following the initial driving condition. The standard waveform of the steering input is sinusoidal, but other waveforms (e.g. triangular) may be used. The standard frequency of the steering input is 0,2 Hz, but other frequencies may be used. The amplitude of the steering input shall be sufficient to ensure that adequate test data are available for analysis at the lateral

acceleration level of 1 m/s^2 and that the vehicle and its subsystems are working outside of the hysteretic region.

NOTE 1 To accomplish this goal, some vehicles might require peak lateral accelerations of 2 m/s^2 or more.

Details of the steering input frequency and waveform, and the lateral acceleration amplitude shall be reported.

Throughout the test, the waveform of the steering input shall be as constant as possible. Both the peak amplitude of the steering angle and the angular velocity of the steering wheel through the centre position shall be as constant as possible. A minimum of four consistent cycles of steering input and of vehicle response is required for subsequent data analysis. Variations from the nominal steering frequency may be $\pm 10 \%$.

NOTE 2 In most cases, vehicle responses to the initial steering cycle will include start-up transients. Consequently, these data might not be appropriate for data analyses.

NOTE 3 To aid in establishing the proper zero-reference steering condition, it might be useful to end the procedure by re-establishing the steady-state straight-ahead condition at the end of the test run.

8.5 Transition test procedure

The transition test procedure requires a ramp-steering input following the initial, straight-line driving condition. The test shall be conducted with steering inputs producing both left turns and right turns with a minimum of five repeats in each direction. As indicated in 9.4.1, results from left turns and right turns are combined during data reduction. This process requires that the initial conditions of all tests be as nearly identical as possible. Thus, whenever possible, each test should be initiated at the same point on the test surface with the vehicle travelling in the same direction and under similar wind conditions. Because of the desirability of similar initial conditions, it is also advisable to conduct tests by alternating turns in one direction and then the other, rather than conducting all tests in one direction and then all tests in the other direction.

To avoid inappropriate initial transient response, the ramp-steering input should be started gradually, not abruptly. Commencing at time t_0 , the steering ramp shall be applied until the lateral acceleration of the first vehicle unit reaches a minimum of $1,5 \text{ m/s}^2$ and is high enough that the vehicle and its subsystems are working outside of the hysteretic region. The steering ramp shall be such that the rate of increase of lateral acceleration does not exceed $0,5 \text{ m/s}^2/\text{s}$.

Details of the steering input, angular velocity and duration of application, shall be reported.

9 Data evaluation and presentation of results

9.1 General

General data shall be presented in the test report in accordance with ISO 15037-2 (see Annex A).

At the present level of knowledge, it is not yet known which characteristic values best represent the subjective feeling of the driver. Therefore, the following specified characteristic values represent only examples for the evaluation of results.

NOTE Characteristic values determined from runs performed using different steering inputs, longitudinal velocity or lateral acceleration might not be comparable.

9.2 Time histories

Time histories serve to monitor correct test performance and functioning of the transducers. Time histories of the variables listed in Clause 5 shall be reported for the data selected for analysis.