

BS ISO 7401:2011



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Road vehicles — Lateral transient response test methods — Open-loop test methods

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National foreword

This British Standard is the UK implementation of ISO 7401:2011. It supersedes BS ISO 7401:2003 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee AUE/15, Safety related to vehicles.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Road vehicles — Lateral transient response test methods — Open-loop test methods

*Véhicules routiers — Méthodes d'essai de réponse transitoire
latérale — Méthodes d'essai en boucle ouverte*



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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 7401 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 9, *Vehicle dynamics and road-holding ability*.

This third edition cancels and replaces the second edition (ISO 7401:2003), which has been technically revised.

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 is each complex in itself. A complete and accurate description of the behaviour of the road vehicle must necessarily involve information obtained from a number of different tests.

Since this test method 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 this test method for regulation purposes will require proven correlation between test results and accident statistics.

Road vehicles — Lateral transient response test methods — Open-loop test methods

1 Scope

This International Standard specifies open-loop test methods for determining the transient response behaviour of road vehicles. It is applicable to passenger cars, as defined in ISO 3833, and to light trucks.

NOTE The open-loop manoeuvres specified in this International Standard are not representative of normal driving conditions, but are nevertheless useful for obtaining measures of vehicle transient behaviour in response to several specific types of steering input under closely controlled test conditions. For measurements of steady-state properties, see ISO 4138.

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 2416:1992, *Passenger cars — Mass distribution*

ISO/TR 8725:1988, *Road vehicles — Transient open-loop response test method with one period of sinusoidal input*

ISO/TR 8726:1988, *Road vehicles — Transient open-loop response test method with pseudo-random steering input*

ISO 8855¹⁾, *Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary*

ISO 15037-1:2006, *Road vehicles — Vehicle dynamics test methods — Part 1: General conditions for passenger cars*

3 Terms and definitions

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

4 General conditions

The general conditions specified in ISO 15037-1 shall apply.

1) To be published.

5 Principle

5.1 General

IMPORTANT — The method of data analysis in the frequency domain assumes that the vehicle has a linear response; this is unlikely to be the case over the whole range of lateral accelerations of interest. The standard method of dealing with such a situation is to restrict the input to a sufficiently small range such that linear behaviour can be assumed. If necessary, testing can be performed with several ranges of inputs that, together, cover the entire range of interest.

The primary object of these tests is to determine the transient response behaviour of a vehicle. Characteristic values and functions in the time and frequency domains are considered necessary for characterizing vehicle transient response.

Important characteristics in the time domain are:

- a) time lags between steering-wheel angle, lateral acceleration and yaw velocity;
- b) response times of lateral acceleration and yaw velocity (see 10.2.1 and 10.2.2);
- c) lateral acceleration gain (lateral acceleration divided by steering-wheel angle);
- d) yaw velocity gain (yaw velocity divided by steering-wheel angle); and
- e) overshoot values (see 10.2.3).

These characteristics show correlation with subjective evaluation during road driving.

Important characteristics in the frequency domain are the frequency responses, i.e. amplitudes and phases of:

- lateral acceleration related to steering-wheel angle; and
- yaw velocity related to steering-wheel angle.

5.2 Test methods

There are several test methods for obtaining these characteristics in the domains of time and frequency, the applicability of which depends in part on the size of the test track available.

- a) Time domain:
 - 1) step input; and
 - 2) sinusoidal input (one period).
- b) Frequency domain:
 - 1) random input;
 - 2) pulse input; and
 - 3) continuous sinusoidal input.

These test methods are optional, but at least one of each domain type should be performed. The methods chosen shall be indicated in the general data specified in Annex A and in the presentation of test results specified in Annex B.

It is possible that the characteristic values of lateral acceleration gain and yaw velocity gain, obtained by the different test methods, may not be comparable, owing to one or more of the following circumstances:

- linear versus non-linear vehicle behaviour;
- periodic versus non-periodic steady-state condition;
- steady state versus dynamic vehicle behaviour.

6 Reference system

The reference system specified in ISO 15037-1 shall apply.

The location of the origin of the vehicle axis system (X_V , Y_V , Z_V) is the reference point and therefore should be independent of the loading condition. It is fixed in the longitudinal plane of symmetry at half-wheelbase and at the same height above the ground as the centre of gravity of the vehicle at complete vehicle kerb mass (see ISO 1176).

7 Variables

The following variables shall be determined:

- a) steering-wheel angle, δ_H ;
- b) lateral acceleration, a_Y ;
- c) yaw velocity, $\dot{\psi}$;
- d) longitudinal velocity, v_X .

The following variables may be determined:

- roll angle, ϕ ;
- sideslip angle, β ;
- lateral velocity, v_Y ;
- steering-wheel torque, M_H .

These variables, defined in ISO 8855, are not intended to comprise a complete list.