INTERNATIONAL STANDARD

# ISO 17288-1

First edition
2002-06-01

# Passenger cars — Free-steer behaviour —

## Part 1:
## Steering-release open-loop test method

*Voitures particulières — Comportement volant libre —*

*Partie 1: Méthode d'essai en boucle ouverte avec relâchement du volant*



Reference number
ISO 17288-1:2002(E)

**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.





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.ch
Web www.iso.ch

Printed in Switzerland

# 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 part of ISO 17288 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17288-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 9, *Vehicle dynamics and road-holding ability*.



ISO 17288 consists of the following parts, under the general title *Passenger cars — Free-steer behaviour*:

— *Part 1: Steering-release open-loop test method*

— *Part 2: Steering-pulse open-loop test method*

## Introduction

The dynamic behaviour of road vehicles is a most important part of active vehicle safety. Any given vehicle, together with its driver and the prevailing environment, forms a unique closed-loop system. The task of evaluating dynamic behaviour is therefore very difficult since there is a significant interaction between these driver-vehicle-environment elements, and each element is individually complex in itself. A complete and accurate description of the behaviour of the road vehicle must necessarily involve information obtained from a number of tests of different types. Since they quantify only a small part of the whole handling field, 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 accident avoidance and the dynamic characteristics evaluated by these tests. A substantial amount of effort 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. Therefore, it is not possible to use these methods and test results for regulation purposes at present. The best that can be expected is that the free-steer behaviour tests be used as some of many tests which, taken together, will cover the field of vehicle dynamic behaviour.

Finally, the role of the tyres is important and the test results can be strongly influenced by the type and condition of tyres.



# Passenger cars — Free-steer behaviour —

# Part 1: Steering-release open-loop test method

## 1 Scope

This part of ISO 17288 specifies an open-loop test method for determining the free control stability of a passenger car as defined in ISO 3833, by measurement of the transient behaviour following steering release, starting from a steady-state cornering status.

NOTE The open-loop manoeuvre specified in this part of ISO 17288 is not representative of normal driving conditions, but is nonetheless useful for obtaining a measure of vehicle transient behaviour.

## 2 Normative references



The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 17288. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 17288 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 3833, *Road vehicles — Types — Terms and definitions*

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

ISO 15037-1:1998, *Road vehicles — Vehicle dynamics test methods — Part 1: General conditions for passenger cars*

## 3 Terms and definitions

For the purposes of this part of ISO 17288, the terms and definitions given in ISO 3833 and ISO 8855 apply.

## 4 Principle

This test is intended for evaluating the ability of a vehicle to return to a straight path following steering-wheel release from a steady-state turn.

The initial conditions are defined by a steady-state circular motion. During the test, the driver releases the steering wheel. The steering-wheel angle and the vehicle response are measured and recorded. From the recorded signals, characteristic values are calculated.

# 5 Variables

## 5.1 Reference system

The provisions given in ISO 15037-1:1998, 3.1, apply.

## 5.2 Measurement

Measure the following variables (see ISO 8855):

— longitudinal velocity ($v_X$);

— lateral acceleration ($a_Y$);

— yaw velocity ($\dot{\psi}$);

— steering-wheel angle ($\delta_H$).

# 6 Measuring equipment

## 6.1 Description



All variables shall be measured by means of appropriate transducers, and their time histories shall be recorded using 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 transducer-recorder system |
|---|---|---|
| Longitudinal velocity | 0 m/s to + 50 m/s | ± 0,3 m/s |
| Lateral acceleration | − 15 m/s$^2$ to + 15 m/s$^2$ | ± 0,1 m/s$^2$ |
| Yaw velocity | − 50 °/s to + 50 °/s | ± 0,3 °/s |
| Steering-wheel angle | − 360 ° to + 360 ° | ± 2 ° for $\lvert \delta_H \rvert \leqslant 180$ °<br>± 4 °, otherwise |

Transducers for measuring some of the listed variables are not widely available and not in general use. Many such instruments are developed by users. If any system error exceeds the recommended maximum value, this and the actual maximum error shall be stated in the test report given in annex A of ISO 15037-1:1998.

## 6.2 Transducer installation

The transducer installation shall comply with ISO 15037-1:1998, 4.2. For the steering-wheel angle, the additional requirements given in 6.2.1 of ISO 15037-1:1998 shall apply.

### 6.2.1 Steering-wheel angle

It is recommended that the steering-wheel angle be measured using transducers in conjunction with the original steering wheel of the vehicle. Alternatively, a replacement instrumented steering wheel may be used. In either event, care should be taken to avoid changing the mass centre, inertial properties or friction of the steering system. Any changes shall be recorded in the test report as given in annex B of ISO 15037-1:1998.

NOTE Free control behaviour is known to be sensitive to the friction and inertia characteristics of the steering system. In addition, it is sensitive to the mass and mass offset of the steering wheel.

### 6.3 Data processing

The provisions given in ISO 15037-1:1998, 4.3, apply.

## 7 Test conditions

Test conditions shall be in accordance with ISO 15037-1:1998, clause 5.

## 8 Test procedure

### 8.1 Test report

All details of the test shall be recorded in the test report specified in ISO 15037-1:1998, annexes A and B, under “General comments and/or other relevant details” and “Test method specific data”, respectively.

### 8.2 Warm-up



The warm-up shall be carried out in accordance with ISO 15037-1:1998, 6.1.

### 8.3 Starting conditions of the test



The starting condition for the test is a steady-state circular motion at a prescribed level of lateral acceleration, $a_{Y0}$. The steady-state circular motion shall be in accordance with ISO 15037-1:1998, 6.2.3, except for the following:

— for the time interval from $t_1$ to $t_2$, the standard deviation of the lateral acceleration shall not exceed 3 % of its mean value or 0,2 m/s$^2$, whichever is the higher.

The standard longitudinal velocity shall be 100 km/h; it may vary by steps of ± 20 km/h.

Where possible, the test should be conducted performing alternating left and right turns. The initial prescribed level of lateral acceleration $a_{Y0}$ of 1 m/s$^2$ shall be incremented in steps of, nominally, 1 m/s$^2$, until a limiting condition is reached (see 8.4).

### 8.4 Test execution

From each starting condition, the driver shall suddenly release the steering wheel at the reference point in time, $t_0$ (see ISO 15037-1:1998, Figure 2), while maintaining the throttle constant and placing the vehicle in free control, so that its response is determined by its dynamic characteristics.

Record test data from time $t_1$ for 1 s after the steering oscillation is completely damped or until $t_0 + 5$ s, whichever is the shorter.

The test should be repeated from starting conditions at incremented levels of lateral acceleration until vehicle response becomes divergent, or the limit of lateral adhesion is reached in the starting condition.

# 9 Data analysis

## 9.1 General

General data shall be presented in accordance with the test report given in ISO 15037-1:1998, annexes A and B.

The recorded time history of the relevant variables shall be displayed and examined visually. Results not considered representative shall be discarded.

## 9.2 Ratio between second and first peak of a given variable after steering-wheel release

For each of the variables (see Figure 1)

— sideslip angular velocity,

— yaw velocity, and

— steering-wheel angle:

a) evaluate the function $f(a_{Y0})$ = peak 2/peak 1, at each level of initial lateral acceleration $a_{Y0}$;

b) plot the function $f(a_{Y0})$ vs $a_{Y0}$;

c) compute the linear regression (see Figure 2);

d) calculate $m$, the slope of the linear regression;

e) calculate $q$, the value of the linear regression at a lateral acceleration of 4 m/s$^2$.



NOTE Sideslip angular velocity is usually calculated by the formula:

$$\dot{\beta}(t) = \frac{a_Y(t)}{v_X(t)} - \dot{\psi}(t)$$

where

$a_Y$ is the lateral acceleration of the vehicle;

$v_X$ is the longitudinal velocity of the vehicle;

$\dot{\psi}$ is the yaw velocity of the vehicle.

## 9.3 Value of second peak of a given variable after steering-wheel release

For each of the variables (see Figure 1)

— sideslip angular velocity,

— yaw velocity, and

— steering-wheel angle:

a) evaluate the function $f(a_{Y0})$ = peak 2, at each level of initial lateral acceleration $a_{Y0}$;

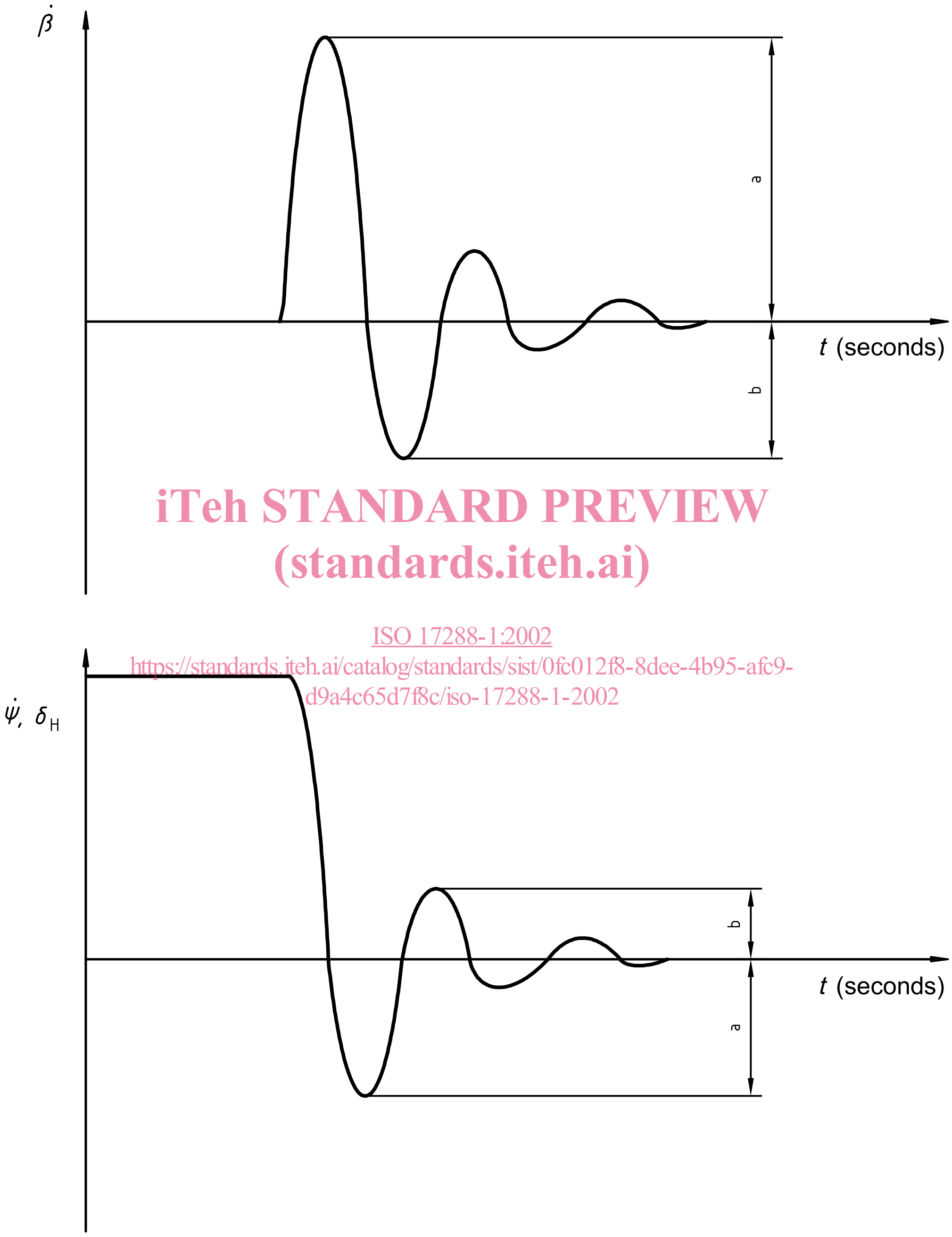
b) plot the function $f(a_{Y0})$ vs $a_{Y0}$;

c) compute the linear regression (see Figure 2);

d) calculate $m$, the slope of the linear regression;

e) calculate $q$, the value of the linear regression at a lateral acceleration of 4 m/s[2].






a Peak 1.

b Peak 2.

**Figure 1 — Peaks of variables after steering-wheel release**