

Passenger cars — Power-off reactions of a vehicle in a turn — Open-loop test method

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- Caravan Club
- Cranfield Impact Centre Ltd.
- Department of Transport
- Motor Industry Research Association
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National foreword

This British Standard has been prepared under the direction of the Automobile Standards Policy Committee. It is identical with ISO 9816:1993, *Passenger cars — Power-off reactions of a vehicle in a turn — Open-loop test method*, published by the International Organization for Standardization (ISO).

Cross-references

International Standard	Corresponding British Standard
ISO 4138:1982	BS AU 189:1983 <i>Method of test for steady state cornering behaviour for road vehicles</i> (Identical)
ISO 8855:1991	BS AU 244:1992 <i>Glossary of terms for road vehicle dynamics and road holding ability</i> (Identical)

The Technical Committee has reviewed the provisions of ISO 1176 and ISO 3833, to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 22, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Introduction

The dynamic behaviour of a road vehicle is a most important part of the 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 is therefore very difficult, since the significant interaction of these driver-vehicle-road elements are each complex in themselves. A description of the behaviour of the road vehicle must inevitably involve information obtained from a number of tests of different types. Since the power-off test procedure quantifies only one small part of the complete handling characteristics, the results of this test can only be considered significant for a correspondingly small part of the overall dynamic behaviour.

In addition, no significant correlation has been found between dynamic characteristics as a result of this test and accident avoidance. A substantial amount of effort is necessary to obtain sufficient and reliable data on the correlation between dynamic characteristics in general and accident avoidance.

Moreover, insufficient knowledge is available concerning the relationship between overall vehicle dynamic properties and accident avoidance. A large amount of work is still necessary to acquire sufficient and reliable data on the correlation between accident avoidance and vehicle dynamic properties in general and the results of this test in particular. Therefore, it is not possible to use this procedure and test results for regulation purposes.

1 Scope

This International Standard defines an open-loop test method for determining the power-off reactions of a vehicle in a turn. It applies to passenger cars as defined in ISO 3833.

It is not possible at present to use this procedure and test results for regulation purposes.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. ISO 1176:1990, *Road vehicles — Masses — Vocabulary and codes*.

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

ISO 4138:1982, *Road vehicles — Steady-state circular test procedure*.

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

3 Principle

The purpose of this test procedure is to determine the power-off effect on course holding and directional behaviour of a vehicle, whose steady-state circular motion is disturbed by power-off only. The sudden release of the accelerator pedal causes this effect.

The initial conditions are defined by constant longitudinal velocity and by a circle with a given radius. The steering wheel angle required for the steady-state circular run shall be constantly maintained during the entire test. During the test the driver input and the vehicle response are measured and recorded. From the recorded signals, characteristic values are calculated.

The variables of motion used to describe the power-off reaction of the vehicle relate to the intermediate axis system X , Y , Z .

The location of the origin of the intermediate axis system, being the reference point, is independent from loading conditions. It is fixed in the longitudinal plane of symmetry at half wheel base and at the same height above the ground as the centre of gravity of the vehicle at complete vehicle kerb mass (see ISO 1176).

4 Variables

The following variables shall be measured:

- moment of power-off initiation, t_0 ;
- steering-wheel angle, δ_H ;
- yaw angle, ψ , or yaw velocity, $\dot{\psi}$;
- longitudinal velocity, v_X ;
- lateral acceleration, a_Y .

It is recommended to measure the following variables as well:

- longitudinal acceleration, a_X ;
- sideslip angle, β , or lateral velocity, v_Y ;
- steering-wheel torque, M_H ;
- pitch angle, θ ;
- roll angle, φ ;

The variables are defined in ISO 8855, except the moment of power-off initiation t_0 , which is the instant at which the accelerator pedal is released.

5 Measuring equipment

5.1 Description

The variables selected from those listed in clause 4 shall be measured by means of appropriate transducers and their time histories recorded by a multi-channel recorder. The typical operating ranges and recommended maximum errors of the transducer and recording system are shown in Table 1. The values in Table 1 are provisional until more experience and data are available.

5.2 Transducer installation

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 the transducer does not measure the values directly, appropriate transformations into the reference system shall be carried out.

5.3 Data processing

The frequency range relevant for this test is between 0 Hz and the maximum utilized frequency $f_{\max} = 5$ Hz. According to the chosen data processing method, analog or digital, the stipulations given in 5.3.1 or 5.3.2 shall be observed.

5.3.1 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 with order four or higher shall be employed. The width of the passband frequency f_0 at -3 dB shall not be less than 8 Hz. Amplitude errors shall be less than $\pm 0,5$ % in the relevant frequency range of 0 Hz to 5 Hz. All analog signals shall be processed with filters having sufficiently similar phase characteristics in order to ensure that time delay differences due to filtering lie within the required accuracy for time measurement.

NOTE 1 During analog filtering of signals with different frequency contents, phase shifts may occur. Therefore a data processing method, as described in 5.3.2, is preferable.

5.3.2 Digital data processing

5.3.2.1 Preparation of analog signals

In order to avoid aliasing, the analog signals shall correspondingly be filtered before digitizing. In this case, low-pass filters with order four or higher shall be employed. The width of the passband (frequency at -3 dB) shall amount to roughly

$$f_0 \geq 5f_{\max}$$

The amplitude error of the anti-aliasing filter should not exceed $\pm 0,5$ % in the usable frequency range. All analog signals shall be processed with anti-aliasing filters having sufficiently similar phase characteristics in order to ensure that time delay differences lie within the required accuracy for time measurement.

Additional filters shall be avoided in the data acquisition string.

Amplification of the signal shall be such that, in relation with the digitizing process, the additional error is less than 0,2 %.

5.3.2.2 Digitizing

The sampling rate shall be higher than the frequency at -3 dB of the anti-aliasing filter and appropriate to the order of the filters used.

5.3.2.3 Digital filtering

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

- pass range 0 Hz to 5 Hz;
- stopband begins 10 Hz to 15 Hz;
- maximum amplitude error in passband $\leq 0,005$ (0,5 %);
- maximum amplitude error in stopband $\leq 0,01$ (1 %).

6 Test conditions

Limits and specifications for the ambient and vehicle test conditions are established in 6.1 to 6.3, and shall be maintained during the test. Any deviations shall be shown in the test report (see Annex A), including the individual diagrams of the presentation of results (see Annex B).

6.1 Test track

All tests shall be carried out on a level, clean, dry and uniform hard road surface, which must not exceed a gradient of 2,5 % at any place.

6.2 Wind velocity

The wind velocity shall not exceed 5 m/s and shall be recorded in the test report (Annex A).

6.3 Test vehicle

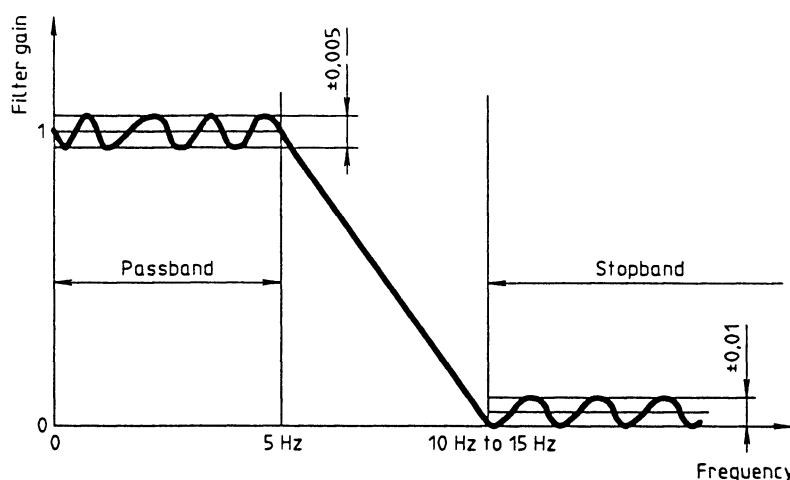
6.3.1 Tyres

For standard tyre condition, new tyres shall be fitted in the appropriate position on the test car. They shall be run in for at least 150 km without excessively harsh use, for example braking, acceleration, cornering, hitting the kerb, etc. They shall have a tread depth of at least 90 % of the original value and shall be manufactured not more than one year before the test.

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

Variable	Typical operating range	Recommended maximum error of the combined transducer and recorder system
Moment of power-off initiation	—	0,05 s
Steering-wheel angle	– 360° to + 360°	± 2° for angles ≤ 180° ± 4° for angles > 180°
Yaw angle	– 180° to + 180°	± 2°
Yaw velocity	– 50°/s to + 50°/s	± 0,5°/s
Sideslip angle	– 15° to + 15°	± 0,5°
Lateral velocity	– 10 m/s to + 10 m/s	± 0,1 m/s
Longitudinal velocity	0 to 50 m/s	± 0,5 m/s
Lateral acceleration	– 15 m/s ² to + 15 m/s ²	± 0,15 m/s ²
Longitudinal acceleration	– 15 m/s ² to + 15 m/s ²	± 0,15 m/s ²
Steering-wheel torque	– 30 N m to + 30 N m	± 0,3 N m
Pitch angle	– 15° to + 15°	± 0,15°
Roll angle	– 15° to + 15°	± 0,15°

NOTE Transducers for measuring some of the listed variables are not widely available and are 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.

**Figure 1 — Required characteristics of phaseless digital filters**

Tyres shall be inflated to the pressure as specified by the vehicle manufacturer for the test vehicle configuration. The tolerance for setting the cold pressure is $\pm 5 \text{ kPa}$ ¹⁾ for pressures up to 250 kPa and $\pm 2 \%$ for pressures above 250 kPa.

The test may also be performed with tyres in any state of wear as long as at the end of the test they retain a minimum of 1,5 mm of tread depth in the whole contact width across the whole breadth of the tread (see note 2) and around the whole circumference of tyre.

NOTE 2 As in certain cases the tread depth has a significant influence on test results, it is recommended that it should be taken into account when making comparisons between vehicles or between tyres.

Tread breadth is the width of that part of the tread which, with the tyre correctly inflated, contacts the road in normal straight-line driving.

¹⁾ 1 kPa = 10^{-2} bar = 10^3 N/m^2