

---

---

**Heavy commercial vehicles and  
buses — Test method for yaw stability  
— Sine with dwell test**

*Véhicules utilitaires lourds et autobus — Méthodes d'essai pour la  
stabilité en lacet — Essai de sinus modifié avec pause*

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO 18375:2016](https://standards.iteh.ai/catalog/standards/sist/3617d274-d17d-43dc-9d6e-66d0f0522ac6/iso-18375-2016)

<https://standards.iteh.ai/catalog/standards/sist/3617d274-d17d-43dc-9d6e-66d0f0522ac6/iso-18375-2016>



**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

ISO 18375:2016

<https://standards.iteh.ai/catalog/standards/sist/3617d274-d17d-43dc-9d6e-66d0f0522ac6/iso-18375-2016>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2016, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Ch. de Blandonnet 8 • CP 401  
CH-1214 Vernier, Geneva, Switzerland  
Tel. +41 22 749 01 11  
Fax +41 22 749 09 47  
copyright@iso.org  
www.iso.org

# Contents

|  | Page      |
|--|-----------|
| <b>Foreword</b> .....  | <b>iv</b> |
| <b>Introduction</b> .....  | <b>v</b>  |
| <b>1 Scope</b> .....   | <b>1</b>  |
| <b>2 Normative references</b> .....  | <b>1</b>  |
| <b>3 Terms and definitions</b> .....   | <b>1</b>  |
| <b>4 Principle</b> .....   | <b>2</b>  |
| <b>5 Measuring equipment</b> .....   | <b>2</b>  |
| <b>6 Variables</b> .....   | <b>3</b>  |
| <b>7 Test conditions</b> .....   | <b>4</b>  |
| 7.1 General.....   | 4         |
| 7.2 Test track.....  | 4         |
| 7.3 Test vehicle.....  | 4         |
| 7.3.1 Safety equipment.....  | 4         |
| 7.3.2 Loading conditions.....  | 4         |
| 7.3.3 Test equipment.....  | 4         |
| <b>8 Test method</b> .....   | <b>5</b>  |
| 8.1 Initial driving condition.....   | 5         |
| 8.2 Determination of the initial steering-wheel angle amplitude.....             | 5         |
| 8.3 Performance of the steering procedure.....                                   | 5         |
| <b>9 Data evaluation</b> .....   | <b>5</b>  |
| 9.1 General.....   | 5         |
| 9.2 Characteristic values.....   | 5         |
| <b>Annex A (normative) Test report — General data and test conditions</b> .....  | <b>9</b>  |
| <b>Annex B (informative) Example of reporting of sine with dwell tests</b> ..... | <b>10</b> |
| <b>Bibliography</b> .....  | <b>13</b> |

## 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 33, *Vehicle dynamics and chassis components*.

ISO 18375:2016

<https://standards.iteh.ai/catalog/standards/sist/3617d274-d17d-43dc-9d6e-66d0f0522ac6/iso-18375-2016>

## 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 requires 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.

## iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO 18375:2016](https://standards.iteh.ai/catalog/standards/sist/3617d274-d17d-43dc-9d6e-66d0f0522ac6/iso-18375-2016)

<https://standards.iteh.ai/catalog/standards/sist/3617d274-d17d-43dc-9d6e-66d0f0522ac6/iso-18375-2016>

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

ISO 18375:2016

<https://standards.iteh.ai/catalog/standards/sist/3617d274-d17d-43dc-9d6e-66d0f0522ac6/iso-18375-2016>

# Heavy commercial vehicles and buses — Test method for yaw stability — Sine with dwell test

## 1 Scope

This International Standard describes an open-loop test method for determining the yaw stability of a vehicle on a low friction road surface. It applies to heavy vehicles, that is 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, according to ECE and EC vehicle classification, categories M3, N2, N3, O3 and O4).

The method is intended for vehicles equipped with electronic yaw-stability control systems.

As the results of this test depend largely on local and temporary changes in road surface friction, this International Standard gives recommendations about keeping the friction level as uniform as possible for good reproducibility of the test results.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

<https://standards.iteh.ai/catalog/standards/sist/3617d274-d17d-43dc-9d6e-66d0f0522ac6/iso-18375-2016>

## 3 Terms and definitions

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

### 3.1

#### beginning of steer input

$T_0$

time when the steering-wheel angle input is started

### 3.2

#### end of steer input

$T_1$

time when the steering-wheel angle returns to zero at the completion of the sine with dwell steer input

### 3.3

#### dwell time

$T_d$

time interval when the steer input remains constant at absolute maximum amplitude

### 3.4

#### steer frequency

$f$

$$f = \frac{1}{T_1 - T_0 - T_d}$$

**3.5 maximum steady-state lateral acceleration**

maximum lateral acceleration that the vehicle can sustain for the selected test surface during steady-state cornering at the selected constant longitudinal velocity without yaw or roll instability when the electronic stability control system is disabled.

**3.6 steady-state steering-wheel angle amplitude**

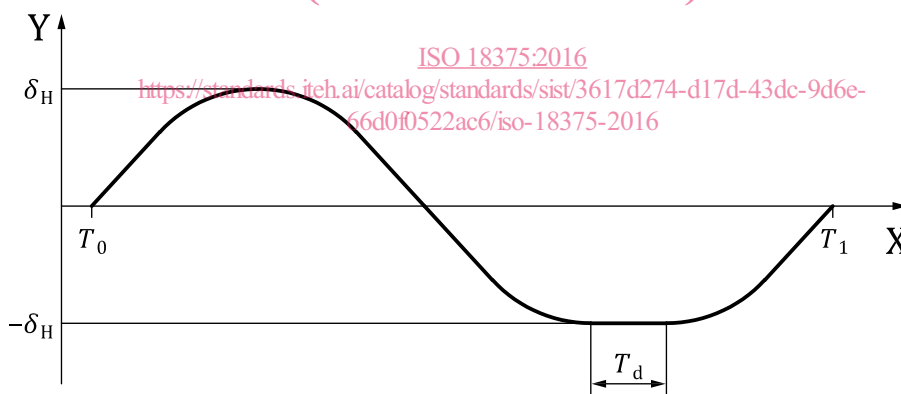
$\delta_{Hss}$   
smallest steering-wheel angle amplitude at *maximum steady-state lateral acceleration* (3.5)

**3.7 time delay**

$\Delta T_i$   
time difference between the yaw velocity of the *i*:th unit and the yaw velocity of the first unit at their first zero crossing when performing the sine with dwell with steady-state steering-wheel angle amplitude,  $\delta_{Hss}$ , when  $0,5 / f + T_0 < t < T_1$

**4 Principle**

The objective of this test method is to study the yaw-stability control of a vehicle on a low friction surface with a selected initial longitudinal velocity,  $v_{x0}$ , which is subjected to a steering-wheel input by a steering machine. The steer input is a sine with dwell of steer frequency,  $f$ , and dwell time,  $T_d$ , as shown in Figure 1. The steering-wheel angle amplitude,  $\delta_H$ , is increased in steps until yaw instability occurs. The results are evaluated with respect to responsiveness, yaw stability, and yaw angle after completion of steer.



**Key**  
X time  
Y steering wheel angle

**Figure 1 — Steering-wheel angle input**

**5 Measuring equipment**

The measuring equipment, transducer installation, and data processing shall be in accordance with ISO 15037-2.



## 6 Variables

The variables that shall be determined for compliance with this International Standard are the following:

- steering-wheel angle,  $\delta_H$ ;
- longitudinal velocity,  $v_x$ ;
- lateral acceleration,  $a_y$ ;
- yaw velocity of each unit,  $\dot{\psi}_i$ ;
- yaw angle of the first unit,  $\psi_1$ ;
- lateral displacement of the first vehicle unit's first axle,  $Y_1$ ;
- indication of intervention of the electronic stability control system (e.g. roll and yaw);
- articulation angles between vehicle units,  $\Delta\psi_i$ ;
- indication of the engagement of the anti-jack-knife device.

It is recommended that the following variables also be determined:

- global position of the first vehicle unit;
- lateral velocity,  $v_y$ , and/or body side slip angle,  $\beta$ , of the first unit;
- roll angle and roll rate;
- longitudinal acceleration,  $a_x$ ;
- wheel brake pressures,  $p_B$ ;
- rotational velocity of wheels,  $\omega_j$ ;
- retarder operation;
- requested engine torque;
- actual engine torque;
- indication of the outriggers touching the ground.

Typical operating ranges of the variables to be determined for this International Standard are shown in [Table 1](#) and in ISO 15037-2.

**Table 1 — Variables, typical operating ranges and recommended maximum errors of variables not listed in ISO 15037-2**

| Variable                            | Typical operating range | Recommended maximum errors of the combined transducer and recorder system |
|-------------------------------------|-------------------------|---|
| Brake pressure in air systems       | 0 kPa to 1 500 kPa      | ±15 kPa   |
| Brake pressure in hydraulic systems | 0 MPa to 30 MPa         | ±0,3 MPa  |
| Rotational velocity of wheels       | 0°/s to 4 000°/s        | ±5°/s   |
| Lateral displacement                | ±10 m                   | ±0,1 m  |
| Yaw angle                           | ±180°                   | ±1°   |

## 7 Test conditions

### 7.1 General

The test conditions described in ISO 15037-2 along with the following changes and additions shall apply to this International Standard.

### 7.2 Test track

All standard tests should be carried out on an even test surface with a uniform coefficient of friction. The friction coefficient should not be below 0,1 or exceed 0,3. The standard friction coefficient is 0,2. The friction coefficient shall be estimated before each test series is conducted. It is recommended that the estimation is conducted by full ABS braking. For each test series, the test surface conditions, friction coefficient, and paving material shall be reported. As the results of this test depend largely on local and temporary changes in road surface friction, this International Standard gives recommendations about keeping the friction level as uniform as possible for good reproducibility of the test results.

Frozen lakes are often used to achieve large, open and flat test surfaces. A uniform test surface is required in order to reduce the effects of friction variations on the test results and, consequently, the test surface should be newly prepared with all excess snow removed. Factors affecting the friction coefficient include sunshine, wind, ambient temperature, fresh snow and test surface usage.

NOTE If a frozen lake is to be used as a test surface, then the maximum vehicle load and/or test speed can be limited by the strength of the ice.

**iTeh STANDARD PREVIEW**  
(standards.iteh.ai)

### 7.3 Test vehicle

#### 7.3.1 Safety equipment

An anti-jack-knife device shall be used on vehicle combinations. It shall allow articulation angles large enough not to influence the maximum performance of the electronic stability control system. Outriggers shall be used when there is a risk of rollover. The outriggers should be mounted at a height that corresponds to roll instability.

NOTE There is a risk of rollover when the test surface friction coefficient exceeds 0,3 and/or the vehicle loading configuration results in a high centre of gravity.

#### 7.3.2 Loading conditions

The loading conditions shall be in accordance with ISO 15037-2.

#### 7.3.3 Test equipment

The vehicle shall be equipped with a steering machine including driver emergency override functionality. The machine shall be programmable for the sine with dwell input with different amplitudes and frequencies. The steering machine should fulfil the requirements shown in [Table 2](#).

**Table 2 — Performance requirements on the steering machine**

| Variable                 | Typical operating range | Recommended maximum errors of the combined transducer and recorder system |
|--------------------------|-------------------------|---|
| Steering-wheel torques   | -40 Nm to 40 Nm         | ±0,2 Nm   |
| Steering-wheel amplitude | -360° to 360°           | 0,25°   |

## 8 Test method

### 8.1 Initial driving condition

The initial condition for the test shall be driving straight ahead as specified in ISO 15037-2. A nominal initial longitudinal velocity,  $v_{x0}$ , is recommended to be selected between 40 km/h to 80 km/h. The standard longitudinal velocity is 50 km/h. It is also recommended to conduct the test at higher velocity if possible.

### 8.2 Determination of the initial steering-wheel angle amplitude

The vehicle shall be driven at the selected initial longitudinal velocity throughout the test. The steering-wheel angle amplitude is slowly increased until maximum steady state lateral acceleration is reached, which corresponds to the steering-wheel angle amplitude,  $\delta_{HSS}$ .

NOTE To save time, an estimation of  $\delta_{HSS}$  based on wheelbase, understeer gradient, steering ratio, friction coefficient, and initial longitudinal velocity can be used to determine the initial steering-wheel angle amplitude.

### 8.3 Performance of the steering procedure

The steer input shall be as described in [Figure 1](#). After the time,  $T_1$ , the steer angle shall be zero until the test run is finished. During the whole manoeuvre, the accelerator pedal shall be kept constant or cruise control shall be used. Either option shall be used for the whole test series. For manual transmissions, a gear position that gives an engine speed as close as possible to the maximum rpm shall be chosen. If the vehicle is equipped with a mechanical differential lock, it shall be disengaged.

To assure oversteering behaviour in the second phase of the manoeuvre, it is recommended that the steer input frequency,  $f$ , is between 0,2 Hz and 0,5 Hz and the dwell time,  $T_d$ , is between 0,5 s and 1 s. The standard steer frequency is  $f = 0,3$  Hz with a dwell time of  $T_d = 0,75$  s. Other frequencies and dwell times, within the specified ranges, are also recommended to be evaluated in order to obtain a more comprehensive characterization of the vehicle performance. The initial steering input amplitude shall be just below  $\delta_{HSS}$  and is incremented in steps not exceeding  $5^\circ$  for subsequent test runs. Each test run shall be repeated at least three times in both the clockwise and counter clockwise turn directions.

The amplitude error compared to the true wave form may not exceed  $\pm 0,5$  % of the first peak. A test run is finished after reaching steady state or when severe yaw or roll instability occurs.

## 9 Data evaluation

### 9.1 General

General data and test conditions shall be presented in the test report in accordance with ISO 15037-2:2002, Annex A. For every change in vehicle loading or configuration, the general data shall be documented.

For every test run, time histories of the variables listed in [Clause 6](#) shall be presented. Apart from their evaluation purposes, the time histories serve to monitor correct test performance and functioning of the transducers.

### 9.2 Characteristic values

The following characteristic values shall be determined for each individual test run.