INTERNATIONAL STANDARD

ISO 7975

Third edition
2006-04-01

Passenger cars — Braking in a turn — Open-loop test method

Voitures particulières — Freinage en virage — Méthode d'essai en boucle ouverte

Reference number
ISO 7975:2006(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.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 7975 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 7975:1996), which has been technically revised.

Introduction

The dynamic behaviour of a road vehicle 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 the dynamic behaviour is therefore very difficult, because of the significant interaction of these driver-vehicle-environment elements, each in itself complex. 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 the braking in turn test procedures quantify 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 needed 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 procedures and test results for regulation purposes.

Test conditions and tyres have a strong influence on test results. Therefore, only vehicle dynamic properties obtained under identical test and tyre conditions are comparable to one another.

Passenger cars — Braking in a turn — Open-loop test method

1 Scope

This International Standard specifies an open-loop test procedure to examine the effect of braking on course holding and directional behaviour of a vehicle. Specifically, the method determines how the steady-state circular response of a vehicle is altered by a braking action only. This International Standard applies to passenger cars as defined in ISO 3833 and to light trucks.

The open-loop manoeuvre specified in this test method is not representative of real driving conditions, but is useful to obtain measures of vehicle braking behaviour resulting from control inputs under closely controlled test conditions.

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

ISO 4138, *Passengers cars — Steady-state circular driving behaviour — Open-loop test methods*

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

ISO 15037-1:1998 [1)], *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 and the general conditions given in ISO 15037-1 apply.

4 Principle

The purpose of this test is to examine the effect of braking on course holding and directional behaviour of a vehicle. Specifically, the method determines how the steady-state circular response of a vehicle is altered by braking action only.

The initial conditions are defined by constant longitudinal velocity and by a circle with a given radius, as specified by the constant-radius test method of ISO 4138. 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.

1) To be revised.

5 Variables

5.1 Reference system

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

5.2 Variables to be measured

The following variables shall be determined:

— moment of brake application (t_0);

— steering-wheel angle (δ_H);

— lateral acceleration (a_Y);

— longitudinal acceleration (a_X)

— longitudinal velocity (v_X);

— yaw velocity ($d\psi/dt$); and

— sideslip angle (β) and/or lateral velocity (v_Y).

NOTE Strictly speaking, test results based on lateral acceleration should not be used for comparison of the performance of different vehicles. This is because lateral acceleration is measured at right angles to the intermediate X-axis and not perpendicular to the vehicle path. To overcome this difficulty, lateral acceleration can be corrected for vehicle sideslip angle, which gives the centripetal acceleration. However, the extent of this correction is not likely to exceed a few percent and may generally be neglected.

It is recommended that the following variables be determined:

— pressure at master cylinder output or in the brake circuit which activates at least one of the front wheel brakes (p_B); and

— wheel rotation speed ($\omega_1 - \omega_4$).

The variables are defined in ISO 8855 except for stopping distance and the moment of brake application, t_0, which is the instant at which the brake pedal is operated. The actuation of the brake pedal may be determined by the use of a contact switch mounted directly on the brake pedal or a sensor for the brake pedal force which set a trigger signal when the brake pedal force exceeds 10 N.

6 Measuring equipment

6.1 Description

Table 1 of ISO 15037-1:1998 shall apply with the following additions:

Table 1 — Variables, typical operating ranges and recommended maximum errors

Variable	Typical operating range	Recommended maximum error of the combined transducer/recorder system
Moment of brake application	—	0,05 s
Pressure of braking system	30 MPa [a]	± 0,3 MPa
Wheel rotation speed	0 s^{-1} to 200 s^{-1}	± 2 s^{-1}
[a] 1 MPa = 10 bar = 10^6 N/m^2.		

6.2 Transducers and their installation

4.2 of ISO 15037-1:1998 shall apply.

6.3 Data processing

The recording system and data processing requirements contained in 4.3 of ISO 15037-1:1998 shall apply.

7 Test conditions

The test conditions specified in Clause 5 of ISO 15037-1:1998 shall apply.

7.1 General data

General data on the test vehicle shall be recorded as specified in 5.4.1 of ISO 15037-1:1998, with the following additions:

The tyre type, tyre brand, any special equipment on the test vehicle, any deviation in type or operating condition of components from the manufacturer's specification, the odometer reading at the beginning and end of the test, and any other condition that may affect test results shall also be recorded on the test report for general data (see Annex A of ISO 15037-1:1998).

8 Test methods

8.1 Run-in program for newly installed brakes (pads/shoes)

The brake linings (pads/shoes) shall be conditioned following the recommendations of the vehicle manufacturer. If manufacturer's recommendations are not available, the brake linings shall be conditioned using one of the following procedures:

For vehicles with disc/disc braking systems, a total of 60 brake applications shall be performed. From an initial vehicle speed of 100 km/h, the vehicle shall be decelerated to approximately 20 km/h at the following approximate deceleration rates:

— 2 m/s^2 for the first 15 brake applications;

— 3 m/s^2 for the next 15 brake applications;

— 5 m/s^2 for the final 30 brake applications.

For vehicles with disc/drum or drum/drum braking systems, a total of 200 brake applications shall be performed. From an initial vehicle speed of 100 km/h, the vehicle shall be decelerated to approximately 20 km/h at the following approximate deceleration rates:

— 2 m/s^2 for the first 50 brake applications;

— 3 m/s^2 for the next 50 brake applications;

— 5 m/s^2 for the final 100 brake applications.

During these brake applications, brake disc and/or brake drum temperatures must not exceed 200 °C. The tyres used for running in the brakes must not be used for subsequent braking distance measurements.

8.2 Warm-up

The procedure specified in 6.1 of ISO 15037-1:1998 shall be followed to warm up the tyres and other vehicle components prior to the test.

In addition to warming up the braking system, five full stops should be performed from an initial speed of about 100 km/h. In each of these stops, brake actuation should be sufficient to cause the anti-lock braking system to be active throughout the majority of the stop. To avoid excessive strain on the brakes, the temperature of the brake discs (drums) should be below 120 °C at the beginning of each single stop.

8.3 Brake temperature

The temperature of the front brake discs (drums) shall be between 80 °C and 120 °C, and the rear brake discs (drums) shall be less than 120 °C before each test run. If necessary, the brakes shall be cooled between runs. The installation of reliable temperature sensors is recommended to monitor the brake temperatures.

8.4 Initial driving condition

The initial driving conditions for a steady-state circular run, as specified in 6.2.1 and 6.2.3 of ISO 15037-1:1998, shall apply with the initial conditions according to the combinations of radii and lateral acceleration given in Table 2. As it is known that the significance of the results and the discrimination between different vehicles increase with increasing test speed, the standard radius of this path shall be 100 m. Additional radii ranging from 30 m to 200 m may be used and shall be noted in the figures of Annex A. Because of the importance of the initial driving conditions, especially for brake tests, the throttle position shall be observed. For the time interval from t_1 to t_2 (see Figure 2, ISO 15037-1:1998) the standard deviation of the throttle position shall not exceed 10 % of its mean value.

NOTE Results of different radii are not comparable.

Table 2 — Initial test conditions

Condition	Radius	Lateral acceleration		Corresponding longitudinal velocity	
	m	m/s^2	tol., %	km/h	tol., %
Standard	100	5	± 10	81	± 5
Optional	30 to 200	5	± 10	44 to 114	± 5

The initial combination of one radius and one lateral acceleration given in Table 2 could be widened by additional test runs with lateral accelerations other than 5 m/s^2, mainly by steps of 1 m/s^2.

8.5 Performance of the braking procedure

When the initial steady-state driving condition has been reached, the steering wheel is fixed by a mechanical device or, alternatively, is firmly held by the driver. The accelerator pedal shall be released and brakes applied as quickly as possible.

For vehicles with manual transmission, the test shall be performed in the highest gear compatible with the conditions of the test speed given in Table 2. The clutch may be disengaged immediately or at the end of the test run. The option chosen (gear position and clutch disengagement) shall be indicated in the test report (see Annex A).

For vehicles with automatic transmission, the standard drive mode shall be used. The position of the transmission lever and the selected driving programme shall be recorded in the test report (see Annex A).

Cars with adaptive gear selection or CVT may use different gears or ratios at a given speed. For such cars, engine speed shall be recorded for the purpose of determining gear ratio. It shall be recorded in the test report.

The actuation of the brake-pedal or the brake light switch is considered as the moment of brake application, t_0. During braking, the pressure in the braking system or the brake-pedal force or the brake-pedal travel shall be kept as constant as possible (an adjustable stop under the brake-pedal may serve) and the steering wheel shall be fixed until the test run is finished.

The test runs for a combination of radius and lateral acceleration defined in Table 2 shall be made at increasing levels of longitudinal acceleration, until on vehicles with conventional braking system, lock up of at least one of the front wheels occurs (if possible). The test may be continued beyond this point resulting in further wheels locking until lock up of all wheels has occurred, but testing under these conditions may result in rapid and large changes of tyre characteristics, which may cause wide variations in test results. On vehicles equipped with an antilock braking system, the test shall be continued until the peak value of mean longitudinal acceleration at time t_n (see Figure 2) is detected.

The minimum braking action shall correspond to a mean longitudinal acceleration of 2 m/s^2 and shall be increased by increments of not more than 1 m/s^2. If the results vary rapidly with the longitudinal acceleration, smaller increments should be selected.

NOTE Depending on the conditions of load, there could be a certain risk of rollover. If necessary, some safety device is recommended.

8.6 General test description

All necessary variables shall be recorded throughout the manoeuvre from time t_1 (see ISO 15037-1:1998, Figure 2) before brake application until the vehicle comes to a standstill. Data shall be taken for both left and right turns. It is recommended that the test be repeated at least three times so that the results can be examined for repeatability and averaged.

9 Data evaluation and presentation of results

9.1 General

General data on the test vehicle shall be presented on a summary form using the general data test report contained in Annex A of ISO 15037-1:1998. The general test conditions shall be presented using the test conditions test report contained in Annex B of ISO 15037-1:1998.

9.2 Time histories

For every test run, time histories of the variables listed in Clause 5 shall be presented. Apart from their evaluation purposes, the time histories serve to monitor correct test performance and functioning of the transducers.

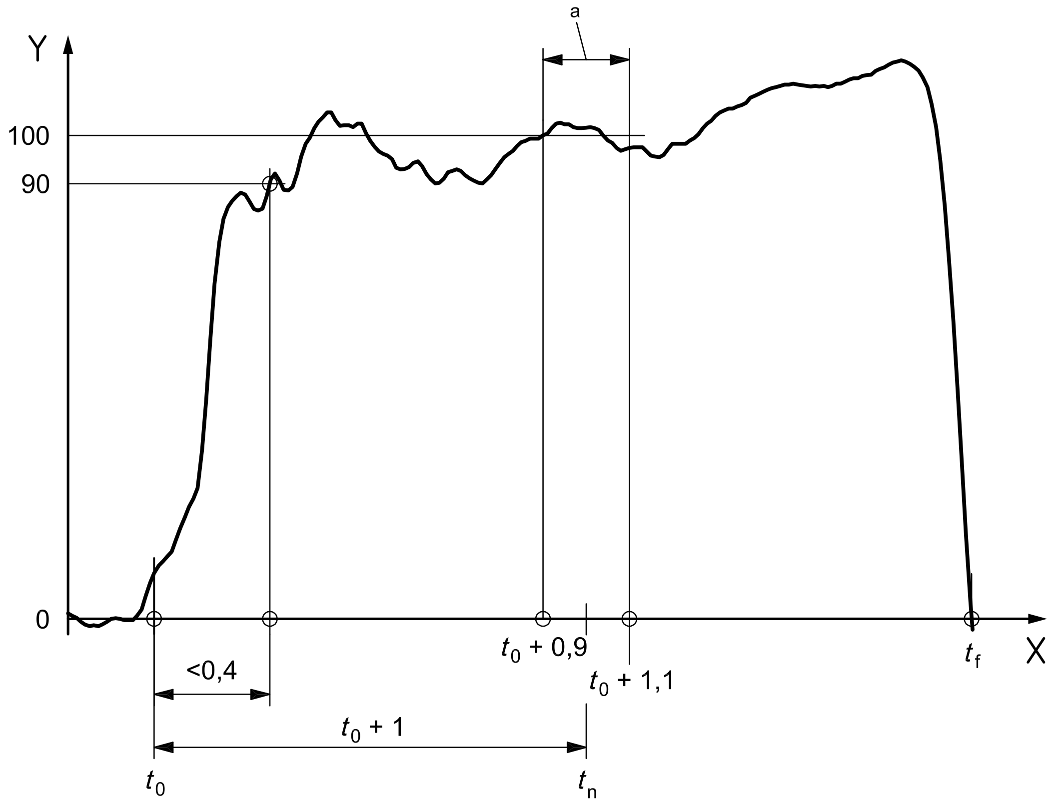
9.3 Braking action

9.3.1 Reference point in time, t_0

The reference point in time, t_0, for the following characteristic values is the moment of the brake-pedal actuation.

9.3.2 Definition of times and requirements for standard evaluation

Figure 1 shows the pattern of longitudinal acceleration during braking versus time.



X time, t (s)

Y longitudinal acceleration (%)

[a] Time interval for evaluation (see 9.4.1)

Figure 1— Definition of times

For the correct performance of a test run, the rise time of the longitudinal acceleration shall not exceed 0,4 s.

The longitudinal acceleration at 1 s after time t_0 is evaluated by taking the mean value during the time interval 0,9 s to 1,1 s after t_0.

The rise time is defined as the difference between the reference point in time t_0 and time t_{90}.

Time t_{90} is the time when the longitudinal acceleration reaches 90 % of the value at 1 s after time t_0.

The time t_f is defined as the time when the longitudinal acceleration reaches the value zero at the end of the braking actuation.

9.3.3 Mean longitudinal acceleration, $-\bar{a}_X$

The mean longitudinal acceleration is the average value of longitudinal acceleration measured during each brake application.

This average value may be obtained by either of the following methods:

a) measuring the distance needed by the vehicle to stop from instant t_0, in which case the mean longitudinal acceleration is given by:

$$-\bar{a}_X = \frac{v_{\text{eff}}^2}{2 \times s_{\text{eff}}}$$

where

s_{eff} is the actual stopping distance, in metres;

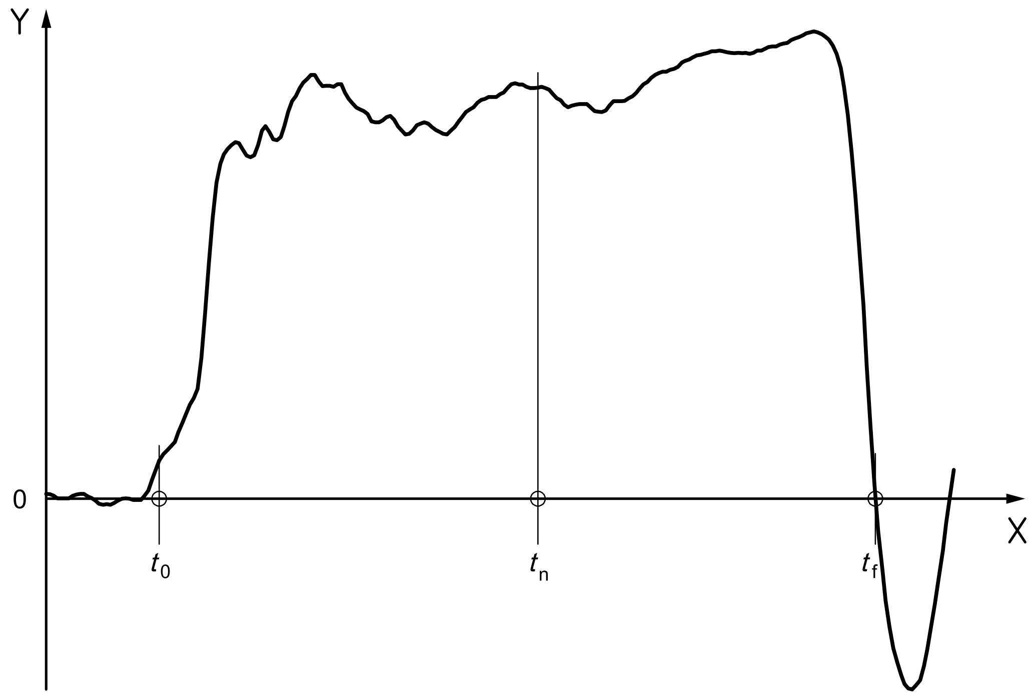
v_{eff} is the actual initial velocity, in metres per second;

b) taking the mean value of the longitudinal acceleration during the time interval t_0 to t_f (see Figure 2).

The method used to determine the mean longitudinal acceleration shall be recorded on the test conditions test report contained in Annex B of ISO 15037-1:1998.

9.3.4 Mean longitudinal acceleration, $-\bar{a}_{X, t_n}$, until time t_n

The mean longitudinal acceleration at any time t_n after brake application is defined as the value during the time interval t_0 to t_n of the longitudinal acceleration (see Figure 2).



X time, t

Y longitudinal acceleration, $-a_X$

Figure 2 — Longitudinal acceleration, $-a_X$, versus time

9.4 Evaluation of characteristic values

9.4.1 General

The characteristic values shall be determined and presented as a function of the mean longitudinal acceleration or the mean longitudinal acceleration at time t_n (see 9.3.3 and 9.3.4). The characteristic values in the steady-state condition are defined as mean values during the time interval − 1,3 s to − 0,3 s before brake application. The other characteristic values are determined during an observation period beginning at t_0 and ending with the standstill of the vehicle. The representative values at t_n shall be calculated by taking the mean value during the time interval t_n − 0,1 s to + 0,1 s. For standard evaluation, the recommended value of time is $t_n = t_0 + 1$ s, but t_n may also assume additional values. If values for t_n in additon to $t_0 + 1$ s are chosen for evaluation of the characteristic values, the values of t_n shall be recorded on the plots of the characteristic values (see Annex A).

For each set of initial conditions, calculate and plot the characteristic values listed below. The reference values of yaw velocity and lateral acceleration used in some of the formulas are those values which would be obtained at time t and longitudinal velocity $v_{X,t}$, had the initial radius R_0 been maintained by the vehicle. They are defined as follows:

Reference yaw velocity: $\dot{\psi}_{\mathrm{Ref},t} = \frac{v_{X,t}}{R_0}$

Reference lateral acceleration: $a_{Y,\mathrm{Ref},t} = \frac{v_{X,t}^2}{R_0}$

9.4.2 Lateral acceleration

Steady-state levels of lateral acceleration in case of method a), or centripetal acceleration in case of methods b), c) and d), may be obtained by any one of the following four methods:

a) The output of an accelerometer, corrected for vehicle roll angle and for the distance of the sensor from the origin of the reference system.

b) The product of the yaw velocity, corrected for vehicle roll angle, and the longitudinal velocity, corrected for sideslip angle.

c) The square of the longitudinal velocity, corrected for sideslip angle, divided by the path radius.

d) The product of the square of the yaw velocity, corrected for vehicle roll angle, and the path radius.

The method used to determine lateral acceleration shall be noted in the test report.

9.4.3 The ratio of the value of the yaw velocity at time t_n to the value of the reference yaw velocity at time t_n (see Figure A.1):

$$\frac{\dot{\psi}_{t_\mathrm{n}}}{\dot{\psi}_{\mathrm{Ref},t_\mathrm{n}}} = f_1\left(-\bar{a}_{X,t_\mathrm{n}}\right)$$

9.4.4 The ratio of the maximum value of the yaw velocity attained during braking to the reference value of the yaw velocity at time t_max, the instant when the maximum value of the yaw velocity is reached (see Figure A.2):

$$\frac{\dot{\psi}_\mathrm{max}}{\dot{\psi}_{\mathrm{Ref},t_\mathrm{max}}} = f_2\left(-\bar{a}_X\right)$$

9.4.5 The difference between the values of the instantaneous yaw velocity at time t_n and the reference yaw velocity at time t_n (see Figure A.3):

$$\Delta\dot{\psi}_{t_\mathrm{n}} = \dot{\psi}_{t_\mathrm{n}} - \dot{\psi}_{\mathrm{Ref},t_\mathrm{n}} = \dot{\psi}_{t_\mathrm{n}} - \frac{v_{X,t_\mathrm{n}}}{R_0} = f_3\left(-\bar{a}_{X,t_\mathrm{n}}\right)$$

9.4.6 The maximum value of the difference between the yaw velocity during braking and the affiliated reference yaw velocity (see Figure A.4):

$$\Delta\dot{\psi}_\mathrm{max} = \left[\dot{\psi}_t - \dot{\psi}_{\mathrm{Ref},t}\right]_\mathrm{max} = \left[\dot{\psi}_t - \frac{v_{X,t}}{R_0}\right]_\mathrm{max} = f_4\left(-\bar{a}_X\right)$$

9.4.7 The instantaneous value of the yaw acceleration at time t_n. The yaw acceleration may be computed by differentiating the yaw velocity (see Figure A.5):

$$\ddot{\psi}_{t_n} = \left.\frac{d\dot{\psi}}{dt}\right|_{t_n} = f_5\left(-\bar{a}_{X,\,t_n}\right)$$

9.4.8 The ratio of the value of the lateral acceleration at time t_n to the reference value of the lateral acceleration at time t_n (see Figure A.6):

$$\frac{a_{Y,\,t_n}}{a_{Y,\,\mathrm{Ref},\,t_n}} = \frac{R_0}{R_{t_n}} = f_6\left(-\bar{a}_{X,\,t_n}\right)$$

9.4.9 The maximum value of the sideslip angle during observation period and the time t_{bm} (Beta-Max), expressing the time passed after t_0 until the maximum was reached (see Figure A.7):

$$\beta_{\mathrm{max}}\Big|_{t_0}^{t} = f_{7-1}\left(-\bar{a}_X\right)$$

$$t_{\mathrm{bm}} = f_{7-2}\left(-\bar{a}_X\right)$$

9.4.10 The difference between the values of the sideslip angle at time t_n and the initial steady-state value of the sideslip angle (see Figure A.8):

$$\beta_{t_n} - \beta_0 = f_8\left(-\bar{a}_{X,\,t_n}\right)$$

9.4.11 The difference between the values of the instantaneous yaw velocity at time t_n and the calculated yaw velocity at time t_n (see Figure A.9):

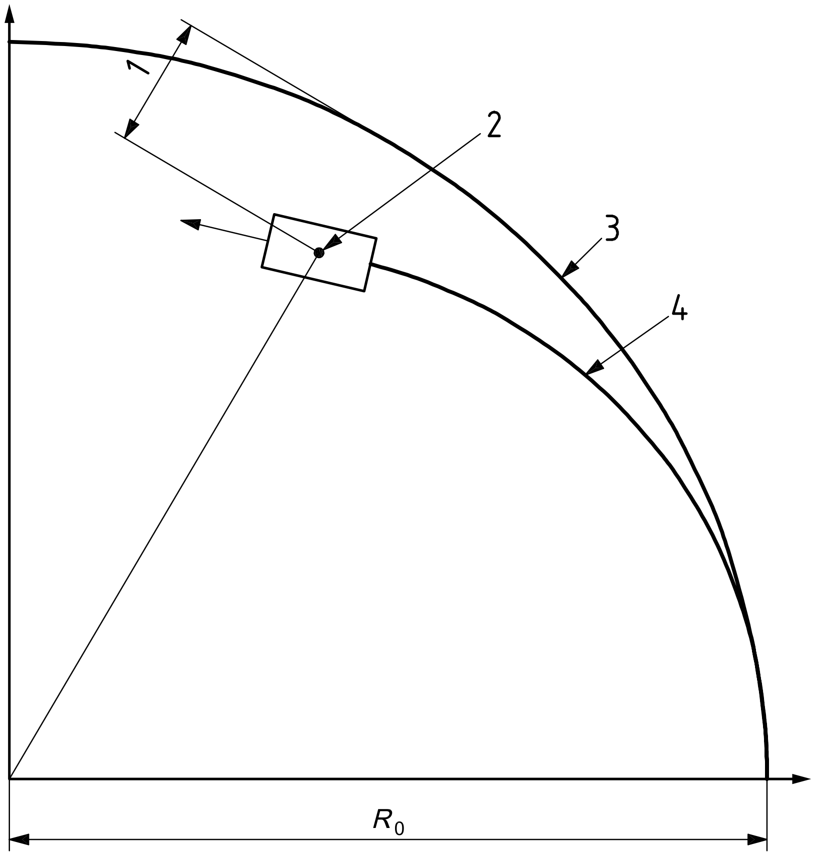
$$\dot{\beta}'_{t_n} = \dot{\psi}_{t_n} - \frac{a_{Y,\,t_n}}{v_{X,\,t_n}} = f_9\left(-\bar{a}_{X,\,t_n}\right)$$

where $\dot{\beta}'$ is the sideslip angle velocity uncorrected for the effects of the sideslip angle itself and the deceleration. It gives information on the vehicle's yaw stability.

9.4.12 The path deviation at time t_n, defined as the radial distance of the reference point and its initial circular path (see Figure A.10):

$$\Delta s_{Y,\,t_n} = f_{10}\left(-\bar{a}_{X,\,t_n}\right)$$

The path deviation is calculated by the path of the reference point in the earth fixed axis system (see Figure 3). The coordinates of the reference point can be determined for example by transforming the vehicle fixed velocity vectors $\vec{v}_X$ and $\vec{v}_Y$ into the earth fixed axis system and subsequent integration.



Key

1 path deviation

2 vehicle referenced point

3 initial circular path

4 path of reference point

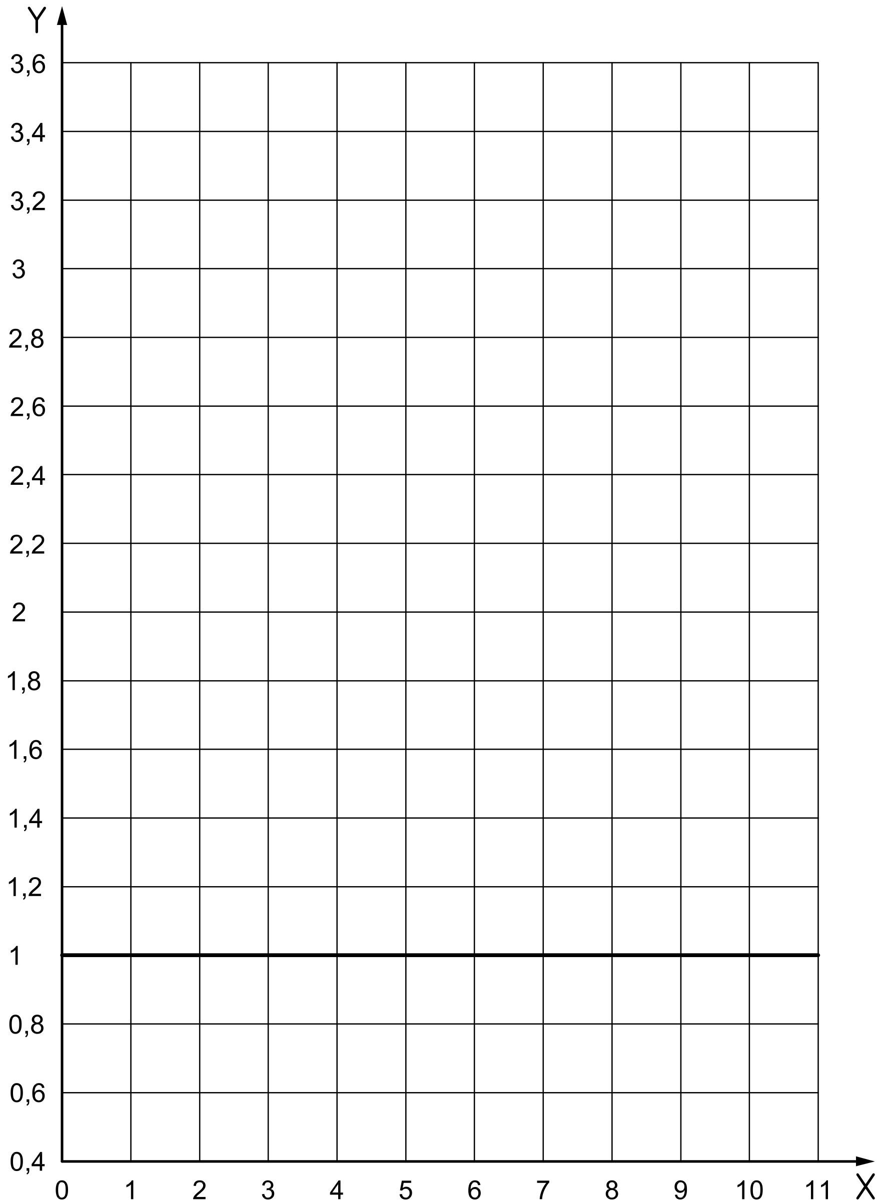
R_0 initial radius

Figure 3 — Definition of path deviation

Annex A
(normative)

Presentation of results

The characteristic values of the vehicle dynamic reaction shall be presented as functions of mean longitudinal acceleration, as shown in Figures A.1 to A.10.



Vehicle:

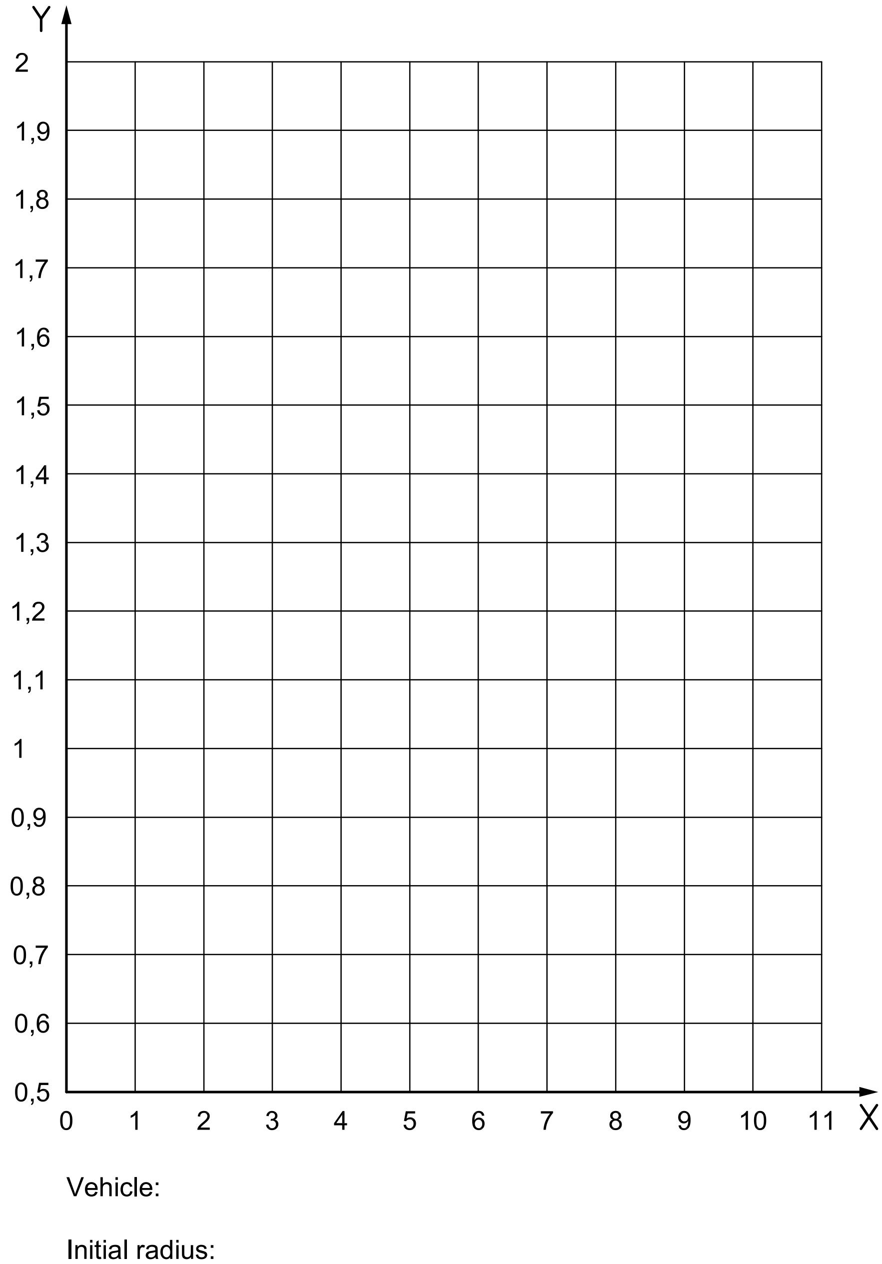
Initial radius:

Time, t_n:

X mean longitudinal acceleration, $-\bar{a}_{X,\, t_n}$ (m/s²)

Y ratio of actual to the reference yaw velocity: $\dfrac{\dot{\psi}_{t_n}}{\dot{\psi}_{\mathrm{Ref},\, t_n}}$

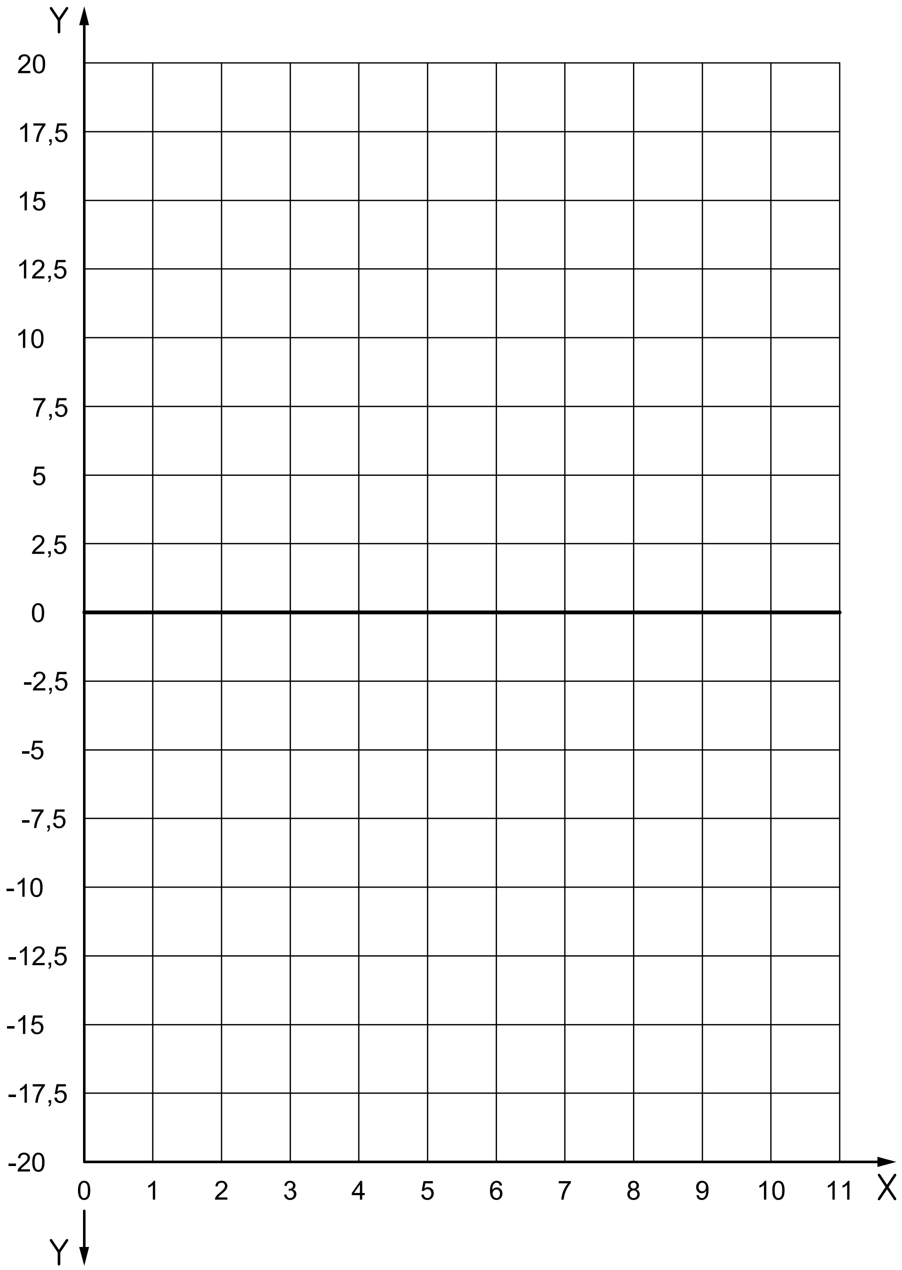
Figure A.1 — The ratio of the value of the yaw velocity, $\dot{\psi}_{t_n}$, at time t_n to the value of the reference yaw velocity, $\dot{\psi}_{\mathrm{Ref},\, t_n}$, at time t_n, as a function of the mean longitudinal acceleration, $-\bar{a}_{X,\, t_n}$



X mean longitudinal acceleration, $-\bar{a}_X$ (m/s^2)

Y ratio of the maximum yaw velocity to the ref. value at time t_{max}: $\frac{\dot{\psi}_{max}}{\dot{\psi}_{Ref,\,t_{max}}}$

Figure A.2 — The ratio of the maximum value of the yaw velocity attained during braking, $\dot{\psi}_{max}$, to the reference value, $\dot{\psi}_{Ref,\,t_{max}}$, at time t_{max}, as a function of the mean longitudinal acceleration, $-\bar{a}_X$



Vehicle:

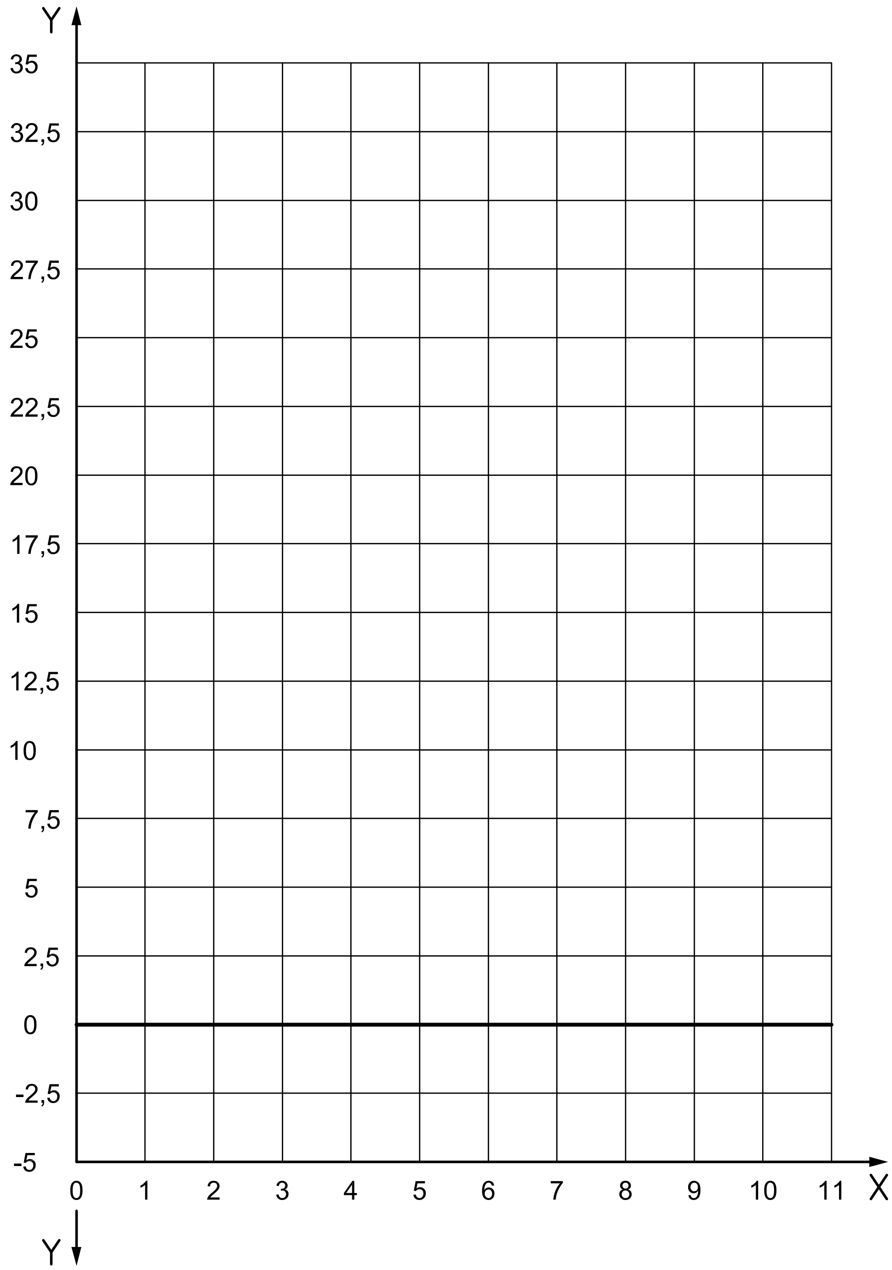
Initial radius:

Time, t_n:

X mean longitudinal acceleration, $-\bar{a}_{X,\,t_n}$ (m/s^2)

Y difference between the actual and the reference yaw velocity: $\dot{\psi}_{t_n} - \dot{\psi}_{\text{Ref},\,t_n}$ (°/s)

Figure A.3 — At time t_n, the difference between the value of the yaw velocity, $\dot{\psi}_{t_n}$, and the reference yaw velocity, $\dot{\psi}_{\text{Ref},\,t_n}$, as a function of the mean longitudinal acceleration, $-\bar{a}_{X,\,t_n}$



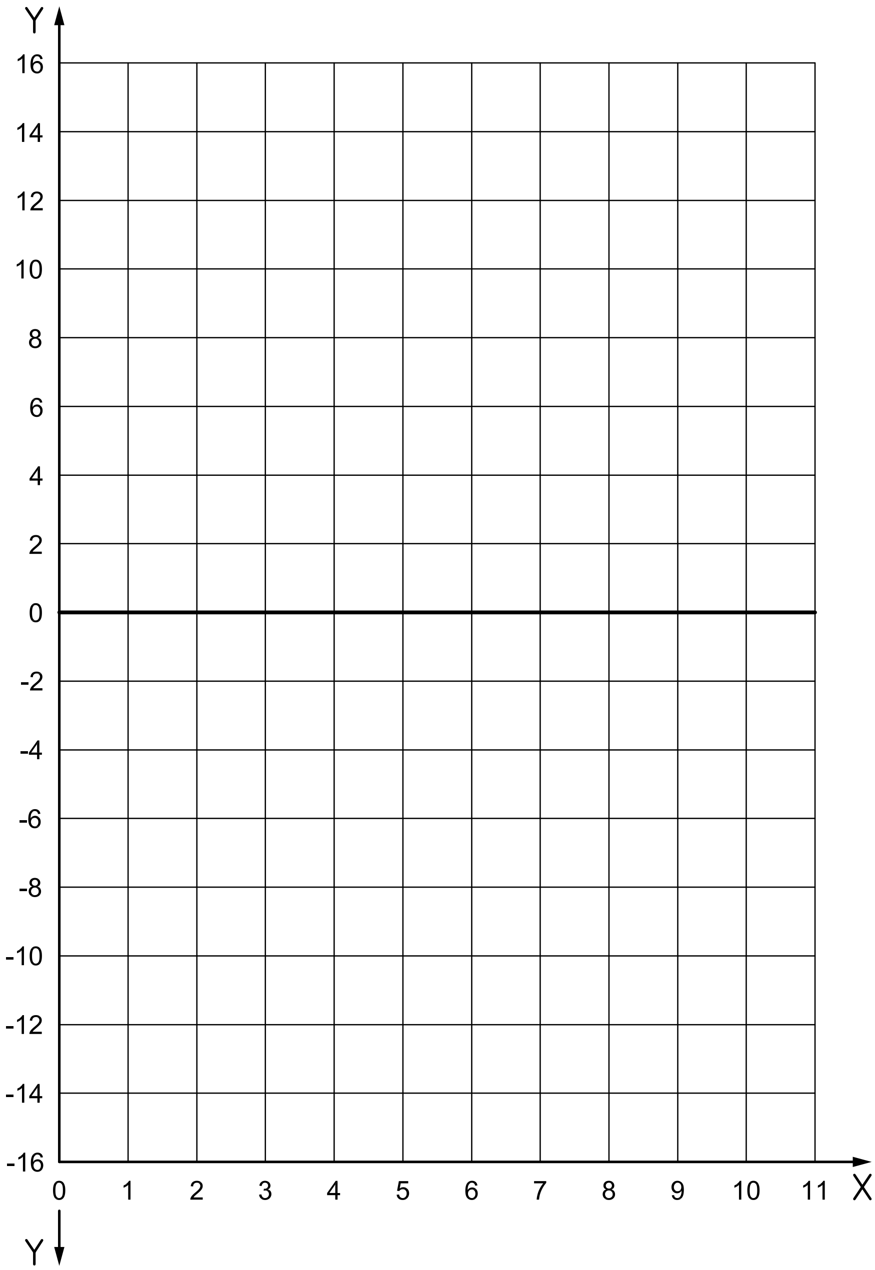
Vehicle:

Initial radius:

X mean longitudinal acceleration, $-\bar{a}_X$ (m/s^2)

Y maximum difference between yaw velocity and reference yaw velocity: $\Delta\dot{\psi}_{max}$ (°/s)

Figure A.4 — The maximum value of the difference between the yaw velocity, $\dot{\psi}$, during braking and the affiliated reference yaw velocity, $\dot{\psi}_{Ref}$, as a function of the mean longitudinal acceleration, $-\bar{a}_X$



Vehicle:

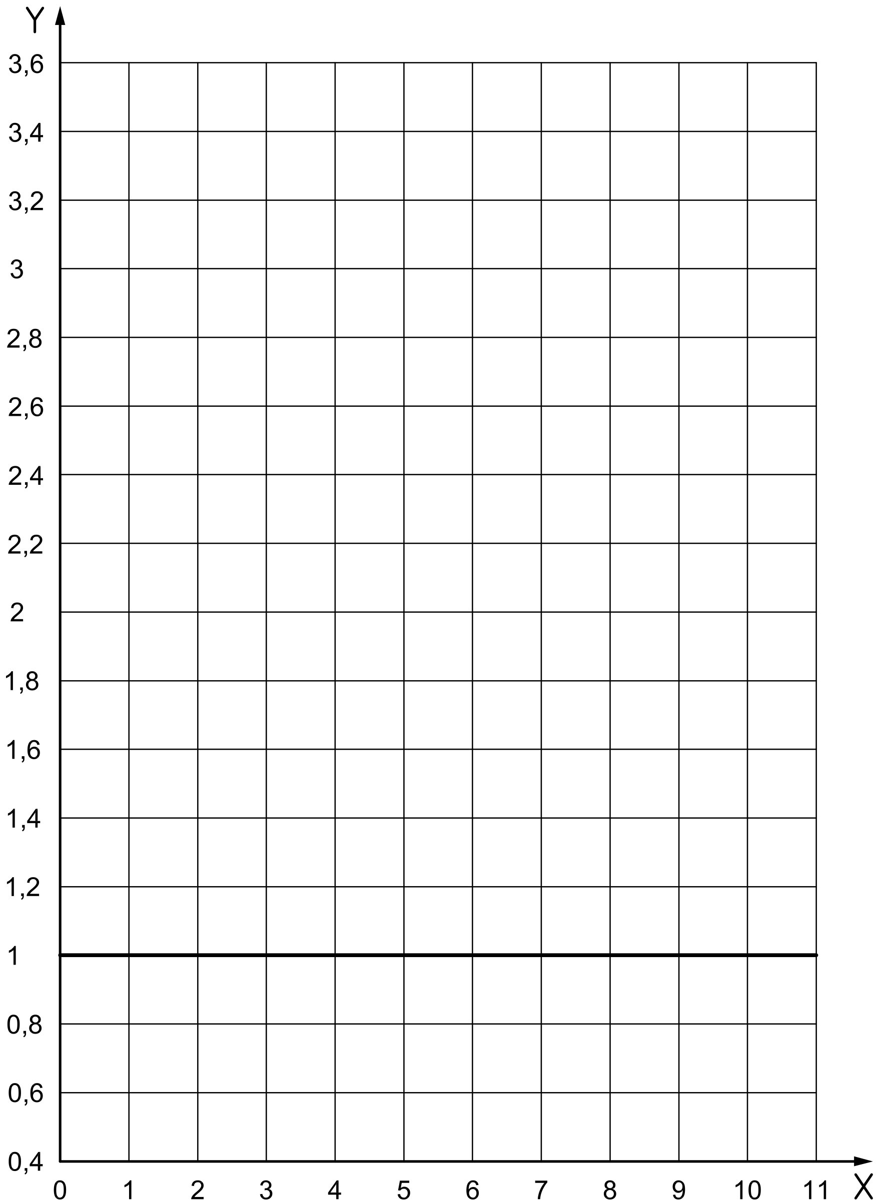
Initial radius:

Time, t_n:

X mean longitudinal acceleration, $-\bar{a}_{X,\,t_n}$ (m/s^2)

Y instanteaneous yaw acceleration: $\ddot{\psi}_{t_n}$ (°/s^2)

Figure A.5 — The instantaneous value of the yaw acceleration, $\ddot{\psi}_{t_n}$, at time t_n, as a function of the mean longitudinal acceleration, $-\bar{a}_{X,\,t_n}$



Vehicle:

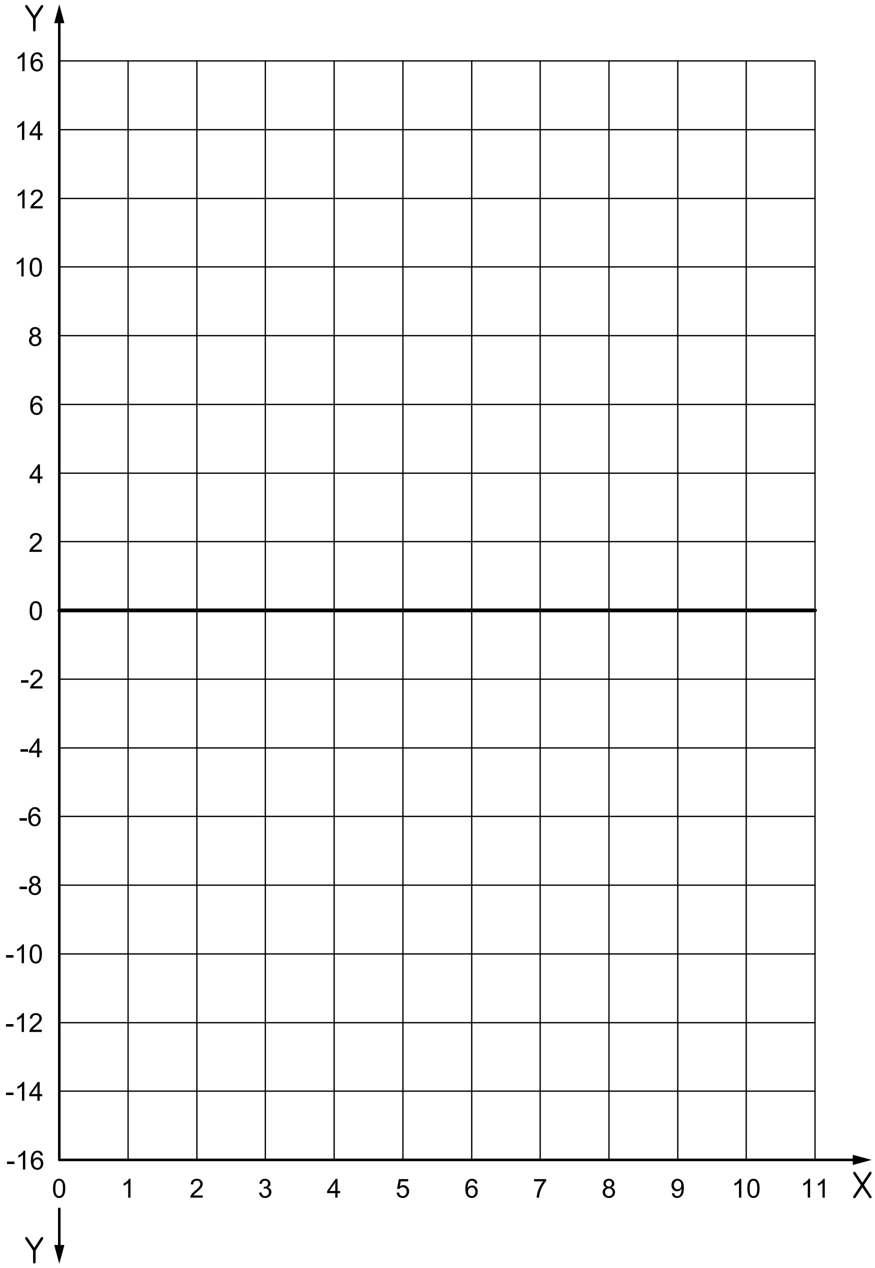
Initial radius:

Time, t_n:

X mean longitudinal acceleration, $-\bar{a}_{X,\, t_n}$ (m/s²)

Y ratio of the actual to the reference lateral acceleration: $\frac{a_{Y,\, t_n}}{a_{Y,\,\mathrm{Ref},\, t_n}}$

Figure A.6 — The ratio of the value of the lateral acceleration, $a_{Y,\, t_n}$, at time t_n to the reference value of the lateral acceleration, $a_{Y,\,\mathrm{Ref},\, t_n}$, at actual time t_n, as a function of the mean longitudinal acceleration, $-\bar{a}_{X,\, t_n}$



Vehicle:

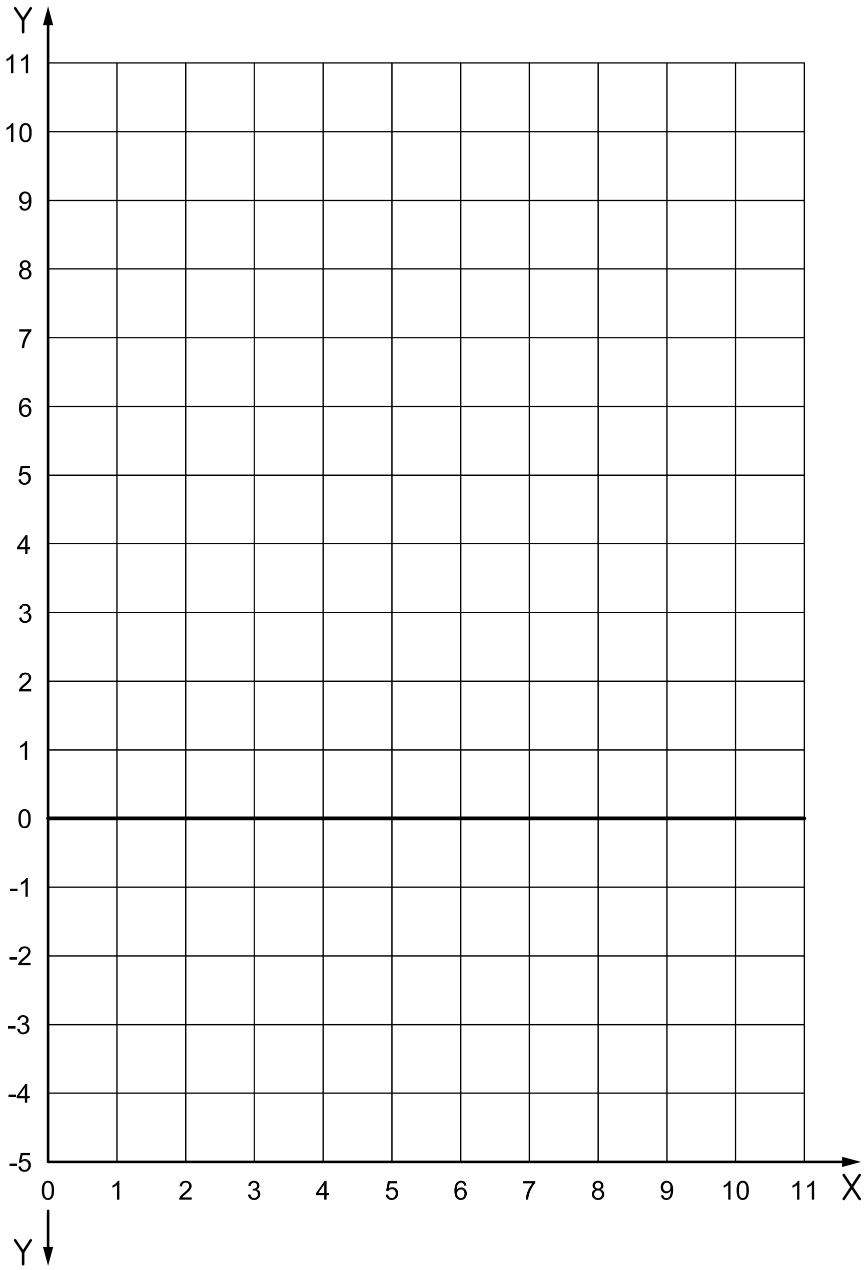
Initial radius:

Time, t_n:

X mean longitudinal acceleration, $-\bar{a}_{X,\,t_n}$ (m/s²)

Y maximum value of the sideslip angle: $\beta_{max}\big|_{t_0}^{t}$ (°)

Figure A.7 — The maximum value of the sideslip angle, $\beta_{max}\big|_{t_0}^{t}$, during the observation period, as a function of the mean longitudinal acceleration, $-\bar{a}_{X,\,t_n}$



Vehicle:

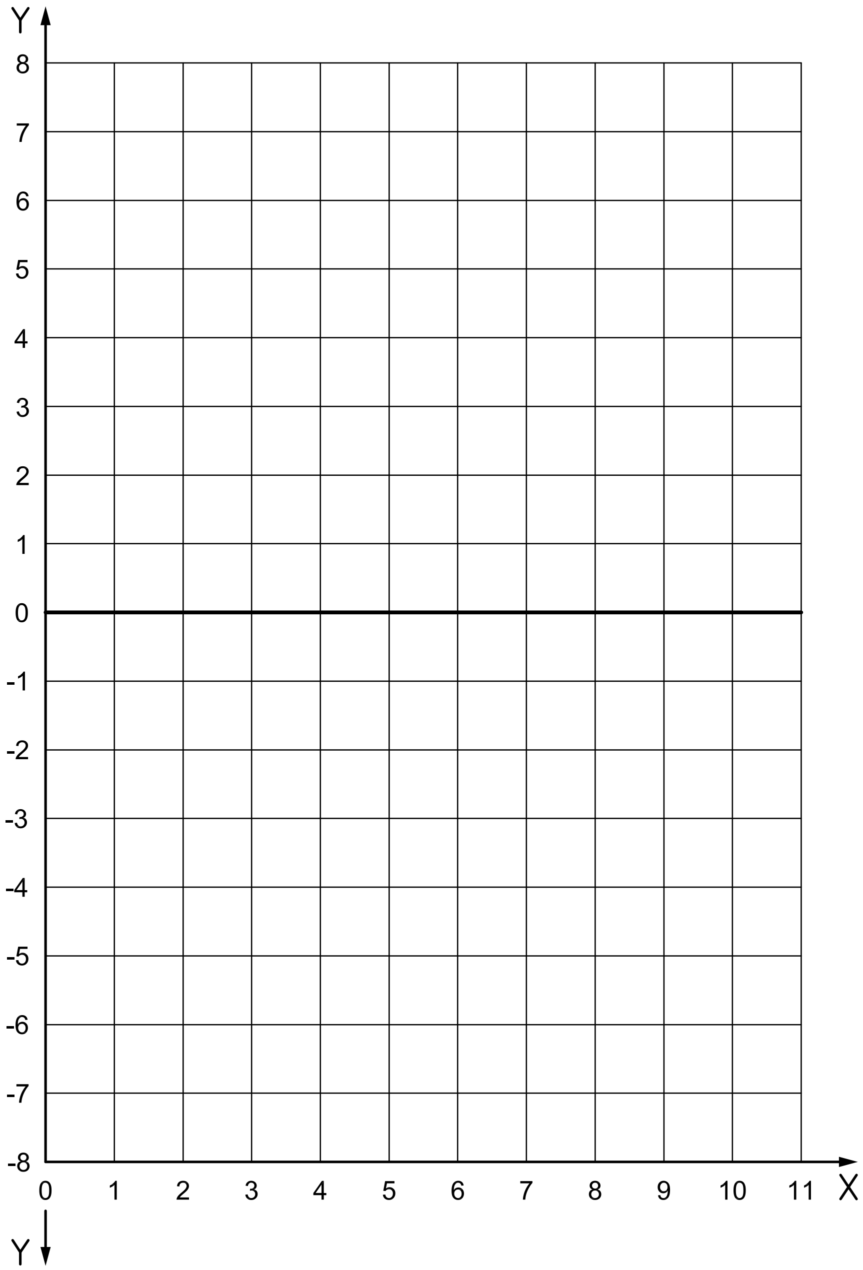
Initial radius:

Time, t_n:

X mean longitudinal acceleration, $-\bar{a}_{X,\,t_n}$ (m/s^2)

Y difference between the actual and the initial sideslip angle: $\beta_{t_n} - \beta_0$ (°)

Figure A.8 — At time t_n, the difference between the value of the sideslip angle, β_{t_n}, and the initial steady-state value of the sideslip angle, β_0, as a function of the mean longitudinal acceleration, $-\bar{a}_{X,\,t_n}$



Vehicle:

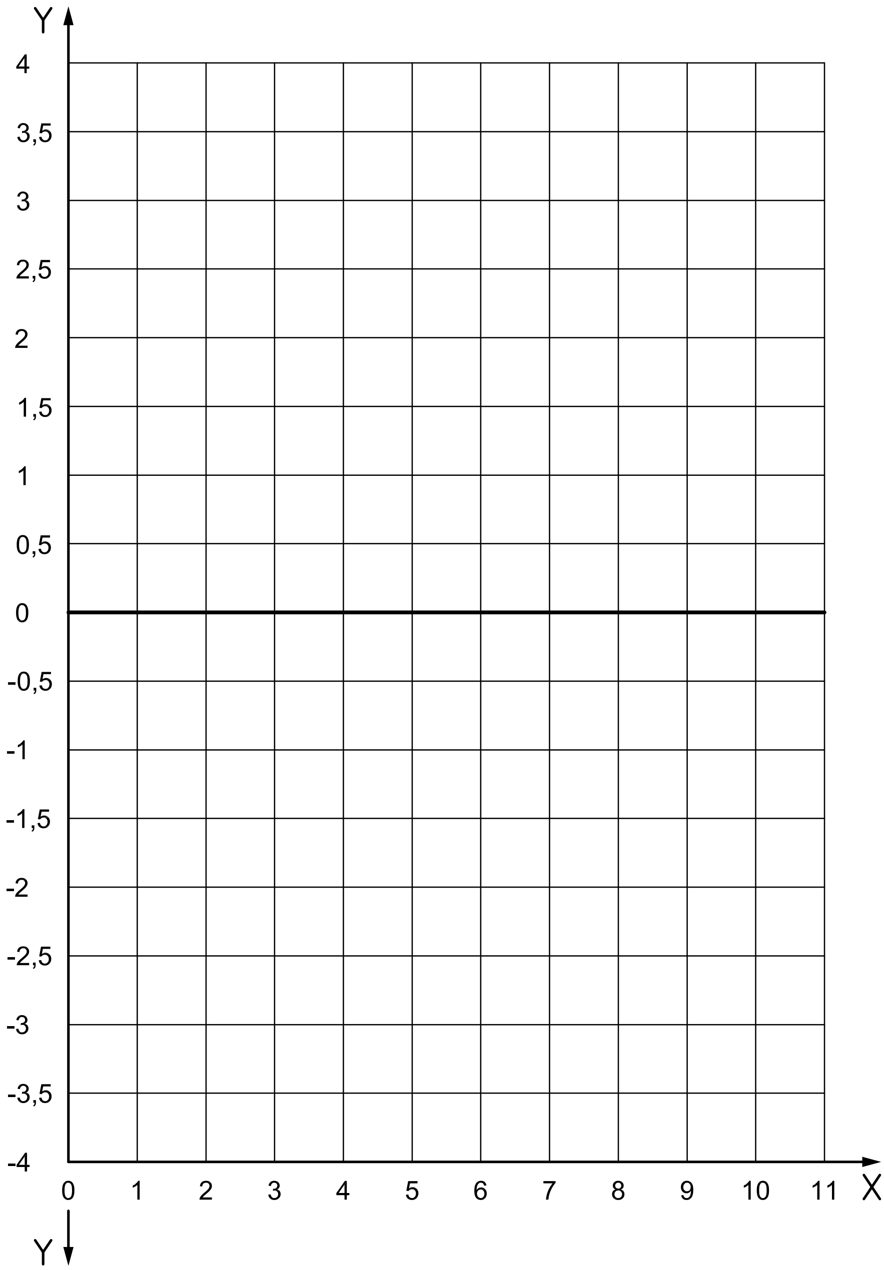
Initial radius:

Time, t_n:

X mean longitudinal acceleration, $-\overline{a}_{X,\,t_n}$ (m/s²)

Y actual sideslip angle velocity, $\dot{\beta}'_{t_n}$ (uncorrected) (°/s)

Figure A.9 — At time t_n, the difference between the value of the yaw velocity, $\dot{\psi}_{t_n}$, and the calculated yaw velocity, as a function of the mean longitudinal acceleration, $-\overline{a}_{X,\,t_n}$ (uncorrected sideslip velocity)



Vehicle:

Initial radius:

Time, t_n:

X mean longitudinal acceleration, $-\bar{a}_{X,\,t_\text{n}}$ (m/s^2)

Y path deviation of the reference point: $\Delta s_{Y,\,t_\text{n}}$ (m)

Figure A.10 — At time t_n, the path of deviation of the reference point, $\Delta s_{Y,\,t_\text{n}}$, as a function of the mean longitudinal acceleration, $-\bar{a}_{X,\,t_\text{n}}$

Bibliography

[1] ISO 1176:1990, *Road vehicles — Masses — Vocabulary and codes*

[2] ISO 2416:1992, *Passenger cars — Mass distribution*

ICS 43.100

Price based on 22 pages