
**Belt drive — V-ribbed belts for the
automotive industry — Fatigue test**

*Transmissions par courroies — Courroies striées pour la construction
automobile — Essai de fatigue*

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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

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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.

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).

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).

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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 WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 41, *Pulleys and belts (including veebelts)*, Subcommittee SC 1, *Friction*.

This second edition cancels and replaces the first edition (ISO 11749:1995), which has been technically revised. It also incorporates Amendment ISO 11749:1995/Amd.1:2003.

Belt drive — V-ribbed belts for the automotive industry — Fatigue test

1 Scope

This International Standard specifies a dynamic test method for the quality control of V-ribbed belts (PK profile) which are used predominantly for accessory drive applications in the automotive industry.

The dimensional characteristics of the belts and of corresponding pulleys are the subject of ISO 9981.

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 683-1, *Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Non-alloy steels for quenching and tempering*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 9981:1998, *Belt drives — Pulleys and V-ribbed belts for the automotive industry — PK profile: Dimensions*

3 Principle

Determination of the performance of a belt under specified conditions on a two-, three-, or four-pulley test machine as described in [Clause 4](#).

The shortest V-ribbed belt which can be tested on the four-pulley test machine (see [Figure 1](#)) is approximately 1 000 mm. Belts with lengths between 800 mm and 1 000 mm inclusive can be tested on the three-pulley test machine (see [Figure 2](#)). Shorter belts should be tested on the two-pulley test machine (see [Figure 3](#)) as described in [6.2.1.2](#).

A number of conditions shall be agreed between the manufacturer and user, including the power to be transmitted, the minimum acceptable life, in hours, and the number of times the belt can be retensioned.

Belt failure occurs when the belt no longer satisfies the agreed conditions.

4 Apparatus

4.1 Dynamic test machine, of robust design so that all components withstand, with virtually no deflection, the stress to which they are subjected.

The test machine shall consist of the following (see [Figures 1, 2, and 3](#)).

4.1.1 Driving pulley, and suitable mechanism for driving it.

4.1.2 Driven pulley, to which a suitable power-absorption unit is connected ([4.1.3](#)).

4.1.3 Power-absorption unit, accurate and capable of calibration.

4.1.4 Temperature control system.

4.1.5 Reverse bending idler pulley, only for four-pulley test machine (see [Figure 1](#)).

4.1.6 Device through which tension may be applied to the belt

- a) in the case of the three- or four-pulley test machine layout, an idler and tensioner pulley (see [Figures 1](#) and [2](#)), or
- b) in the case of the two-pulley test machine layout, a movable pulley (see [Figure 3](#)).

4.1.7 Means of determining belt slip, to an accuracy of $\pm 0,1$ %. The layout of the pulley and the direction of rotation are shown in [Figures 1](#), [2](#), and [3](#).

In order to accommodate different lengths, the position of relevant driving and driven members, the position of the idler pulley and its support (in the case of the three-pulley test machine), and the position of the reverse bending idler pulley (in the case of the four-pulley test machine) shall be adjustable so that the test layout of the pulleys is attainable for each belt length.

So that the tension can be satisfactorily applied to the belt, and in order to allow for belt stretch, the idler pulley and its bearing assembly shall be free to slide, as necessary, in the support bracket along the line of application of the tensioning force.

For the four-pulley test machine in such a case, the line of action of the tensioning force shall bisect the belt layout at the idler pulley and at the reverse bending idler pulley, and shall lie in the plane through the centre of the pulleys (see [Figure 1](#)).

For the three-pulley test machine in such a case, the line of action of the tensioning force shall bisect the belt layout at the idler pulley, shall pass through the axis centre of the idler pulley, and shall lie in the plane through the centre of the idler pulley (see [Figure 2](#)).

The two-pulley test machine shall be constructed so that one of the units (driven or driving) can be moved to accommodate belt lengths of up to 800 mm. A method of locking the movable unit in position for a given tension in the belt shall be provided. So that the tension can be satisfactorily applied to the belt, and in order to allow for belt stretch, the line of action of the tensioning force shall pass through the axis centre of the driven and driving pulleys and shall lie in the plane through the centre of the same pulleys (see [Figure 3](#)).

4.2 Test pulleys, made from steel, as defined in ISO 683-1, with a surface hardness of 55 HRC, conforming to ISO 6508-1. The pulley groove shall have a surface roughness such that the arithmetical mean deviation of the profile R_a is lower than $0,8 \mu\text{m}$.

The characteristics of the test pulleys are given in [Figure 1](#) and the dimensions are given in Table 1 of ISO 9981:1998.

5 Test room conditions

The test temperature shall be

- a) in a test room, at an ambient temperature between $18 \text{ }^\circ\text{C}$ and $32 \text{ }^\circ\text{C}$ (the mean ambient temperature for the duration of the test shall be given with the test result and the atmosphere in the vicinity of the test drive shall be free of draughts from sources other than the belt drive itself), or
- b) in a thermostatically controlled enclosure, a high temperature of $(120 \pm 5) \text{ }^\circ\text{C}$, or
- c) in a thermostatically controlled enclosure, a high temperature of $(85 \pm 5) \text{ }^\circ\text{C}$.

6 Test method

6.1 Test conditions

The rotational frequency of the driving pulley shall be 4 900 min⁻¹ to within ±2 %. The power transmitted is fixed, in kilowatts, for a belt with three to five ribs, and shall be agreed between the manufacturer and user.

The driver pulley speed, in revolutions per minute, shall be used in the torque load calculation, and the torque load shall be kept constant without compensation for loss of driven pulley speed resulting from belt slippage.

The torque load, M , is given by Formula (1)

$$M = \frac{P_s}{N} \times 9\,549 \quad (1)$$

where

- M is the torque load, in newton metres;
- P_s is the specified power, in kilowatts;
- N is the driver speed, in rotations per minute.

The test equipment shall be maintained so as to minimize parasitic loads due to bearing losses, lubricants, etc.

In the case of the three- or four-pulley test machine, the belt-tensioning force, F , in newtons, applied to the idler pulley, and in the case of the two-pulley test machine that applied to the driven unit, shall be such that

$$F = k \times P_s \quad (2)$$

where

- $k = 60$ N/kW, in the case of the three- or four-pulley test machine;
- $k = 110$ N/kW, in the case of the two-pulley test machine.

EXAMPLE For 10,3 kW, $F = 618$ N: for one belt with six ribs = 105 N/rib (in the case of the three- or four-pulley test).

6.2 Procedure

6.2.1 Preparation

6.2.1.1 Three- or four-pulley test machine

Method A: After mounting the belt on the pulleys, apply the specified belt-tensioning force (see 6.1) to the idler pulley and, leaving the idler pulley support bracket free to move in its slide, bring the drive up to the specified rotational frequency (see 6.1). Then apply the relevant load to the driven pulley as quickly as possible. Run the drive under these conditions for 5 min ± 15 s, not including the starting and stopping time. Stop the machine and leave it to stand for at least 10 min.

Then turn the drive manually for several revolutions of the belt and immediately lock the idler pulley support bracket in position.

Method B: After mounting the belt on the pulleys, apply the specified belt-tensioning force (see 6.1) to the idler pulley, leaving the idler pulley support bracket free to move in its slide. Then turn the drive manually for several revolutions of the belt and immediately lock the idler pulley support bracket in position.

6.2.1.2 Two-pulley test machine

Use the same procedure as in 6.2.1.1 with the movable unit taking the place of the idler pulley support.

6.2.2 Test

Start (re-start in the case of method A) the machine, bring the drive up to the specified rotational frequency, apply the test load to the driven pulley, and measure the slip between the driving and driven pulleys.

The drive shall run continuously under these conditions until either the belt fails or the additional slip g exceeds by 4 % the slip measured initially.

The additional slip g , expressed as a percentage, is given by Formula (3):

$$g = (i_o - i_f) \times 100 \quad (3)$$

where

$$i_o = \frac{n_o}{N_o} \quad (4)$$

and

$$i_f = \frac{n_f}{N_f} \quad (5)$$

where

n_o is the initial rotational speed of the driven shaft;

n_f is the final rotational speed of the driven shaft;

N_o is the initial rotational speed of the driving shaft;

N_f is the final rotational speed of the driving shaft.

All rotational speeds shall be measured under the test load.

6.2.3 Retensioning

If the additional belt slip reaches 4 % before belt failure, stop the machine and leave it to stand for at least 20 min. In the case of the three- or four-pulley test machine, unlock the idler support bracket, apply the test tension to the belt, turn the drive manually for two or three revolutions of the belt, re-lock the idler support bracket in position, as described in 6.2.1, and repeat the test specified in 6.2.2.

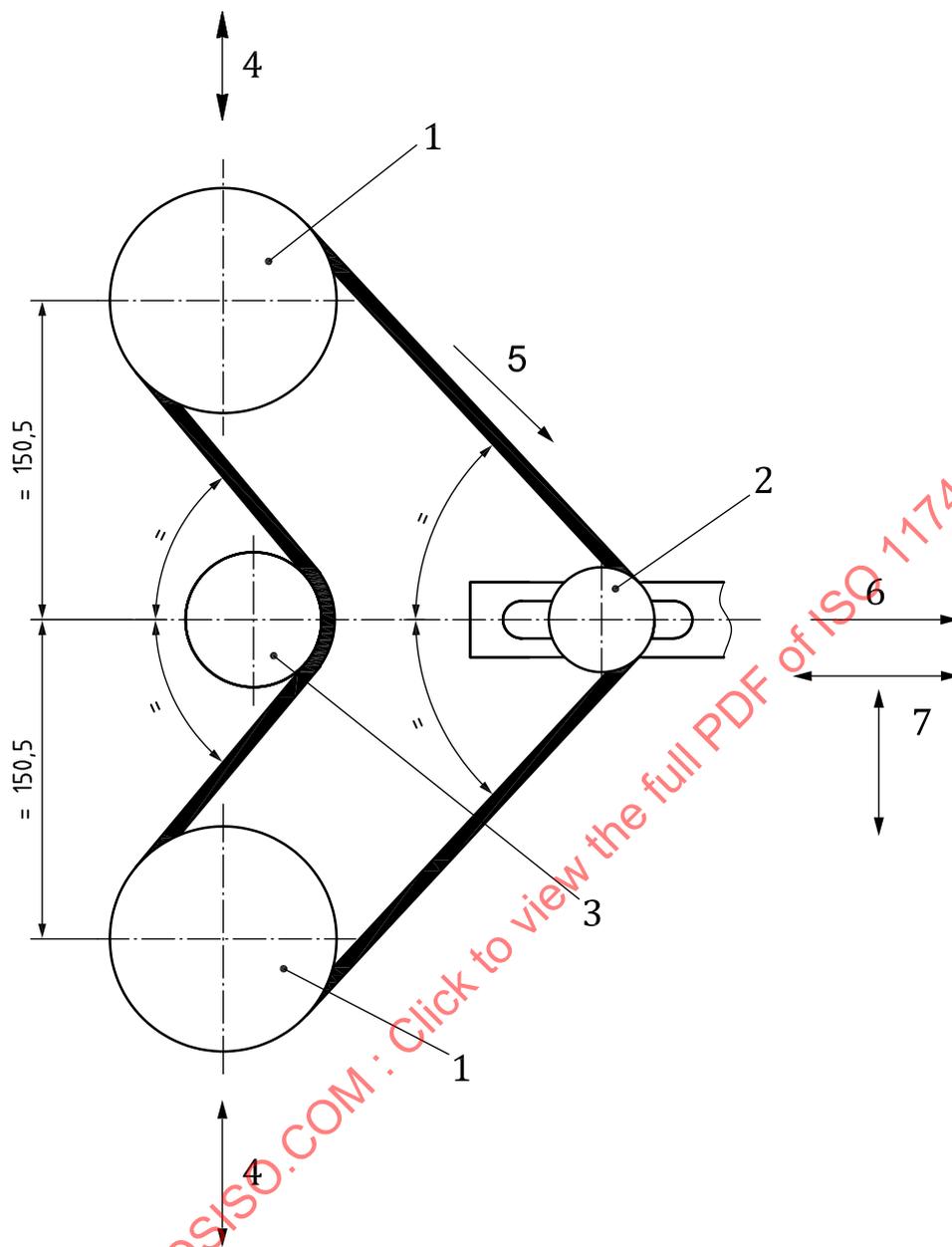
Repeat this procedure whenever the additional slip reaches 4 % before failure, until the belt fails.

7 Test report

The test report shall include at least the following information:

- a) a reference to this International Standard (i.e. ISO 11749);
- b) identification of the belt tested;
- c) the type of machine used (if necessary, the effective diameter of the idler pulley or the outside diameter of the reverse bending idler pulley);
- d) the method used (A or B);
- e) the number of running hours under test to satisfy the agreed conditions;
- f) the transmitted power and the number of ribs;
- g) the number of times and the running hours at which the belt was retensioned;
- h) the mean ambient temperature during the test;
- i) the date of the test.

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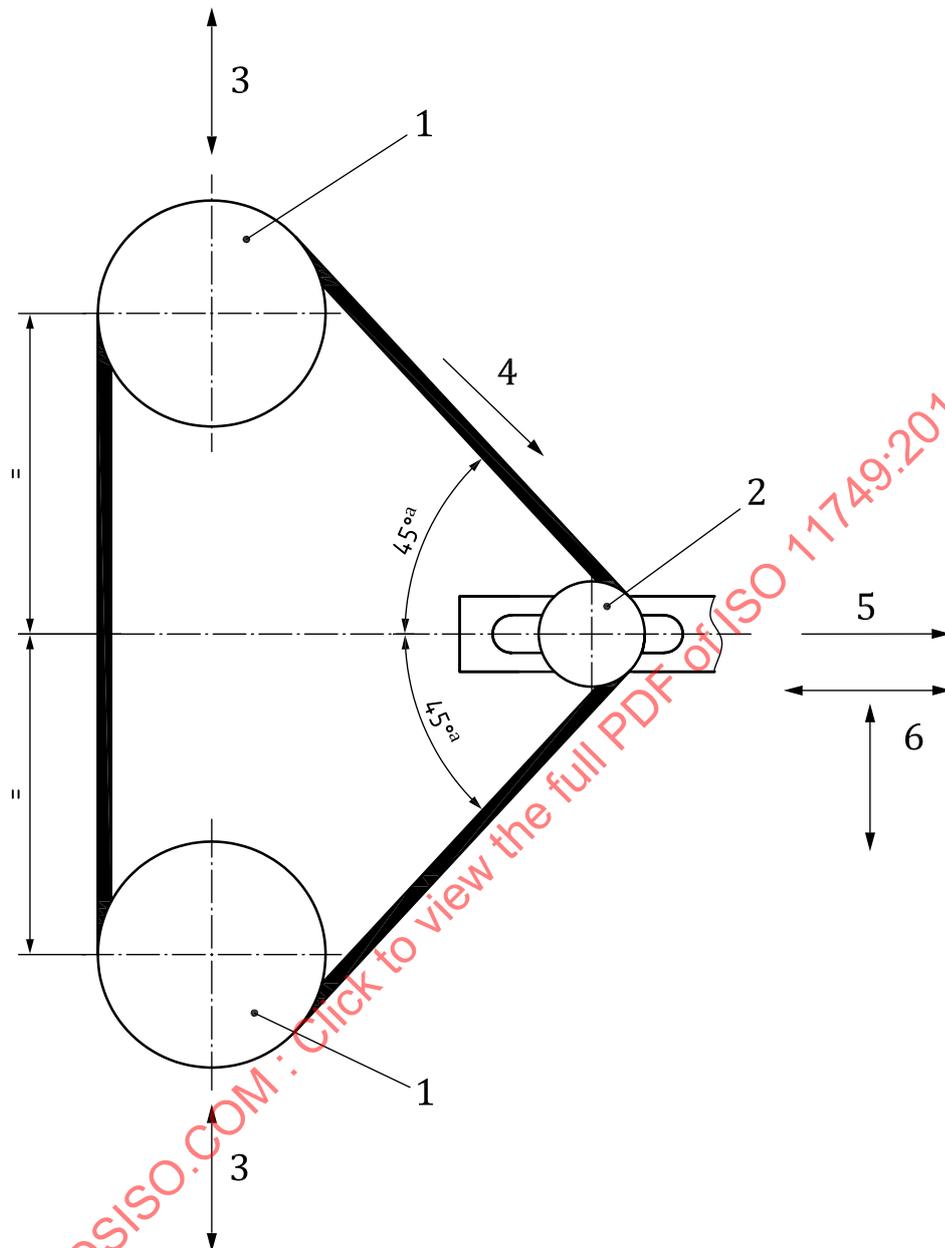


Key

- 1 driven pulley (power-absorption unit)
- 2 idler pulley, set in slide
- 3 reverse bending idler pulley
- 4 direction of adjustment of driven pulley
- 5 direction of rotation
- 6 belt-tensioning force applied to the idler pulley
- 7 direction of adjustment of idler pulley assembly and its support

NOTE Equal (=), the angle as shown by this figure, is specified for the initial test layout and may change slightly with retensioning during the course of the test.

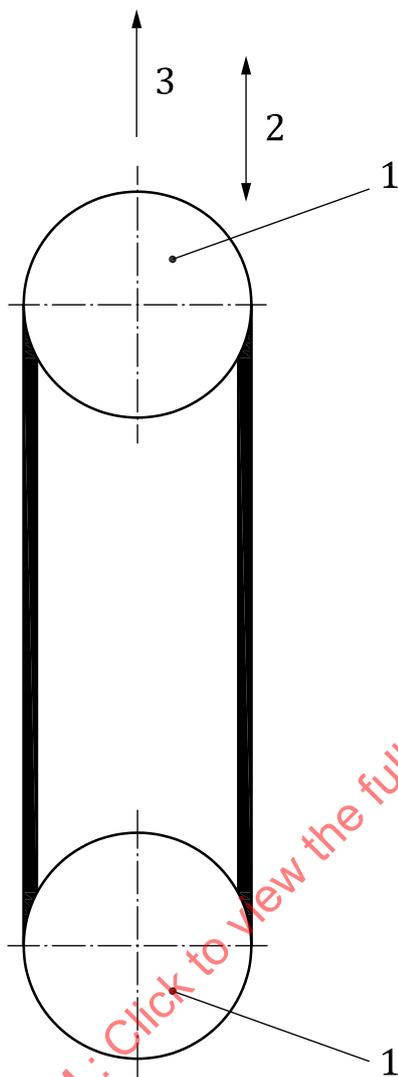
Figure 1 — Four-pulley test machine layout

**Key**

- 1 driven pulley (power-absorption unit)
- 2 idler pulley, set in slide
- 3 direction of adjustment of driven pulley
- 4 direction of rotation
- 5 belt-tensioning force applied to the idler pulley
- 6 direction of adjustment of idler pulley assembly and its support
- a 45° is specified for the initial test layout and may change slightly with retensioning during the course of the test.

Figure 2 — Three-pulley test machine layout

The belt, mounted on the test pulleys, shall be aligned to within $\pm 15'$ in relation to the plane through the centre of each pulley.



Key

- 1 driven pulley (power-absorption unit)
- 2 direction of adjustment of the movable pulley (method of locking in place)
- 3 belt-tensioning force applied to the movable pulley

Figure 3 — Two-pulley test machine layout

The belt, mounted on the test pulleys, can be aligned to within 15' in relation to the plane through the centre of each pulley.