BS ISO 11749:2014

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

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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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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Foreword

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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).

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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 ±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 *Ra* is lower than 0,8 µm.

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 °C and 32 °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 ± 5) °C, or

c) in a thermostatically controlled enclosure, a high temperature of (85 ± 5) °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)

$$M = \frac{p_s}{N} \times 9\,549 \tag{1}$$

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

$$F = k \times P_s \tag{2}$$

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):

$$g = (i_o - i_f) \times 100 \tag{3}$$

where

$$i_o = \frac{n_o}{N_o} \tag{4}$$

and

$$i_f = \frac{n_f}{N_f} \tag{5}$$

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);

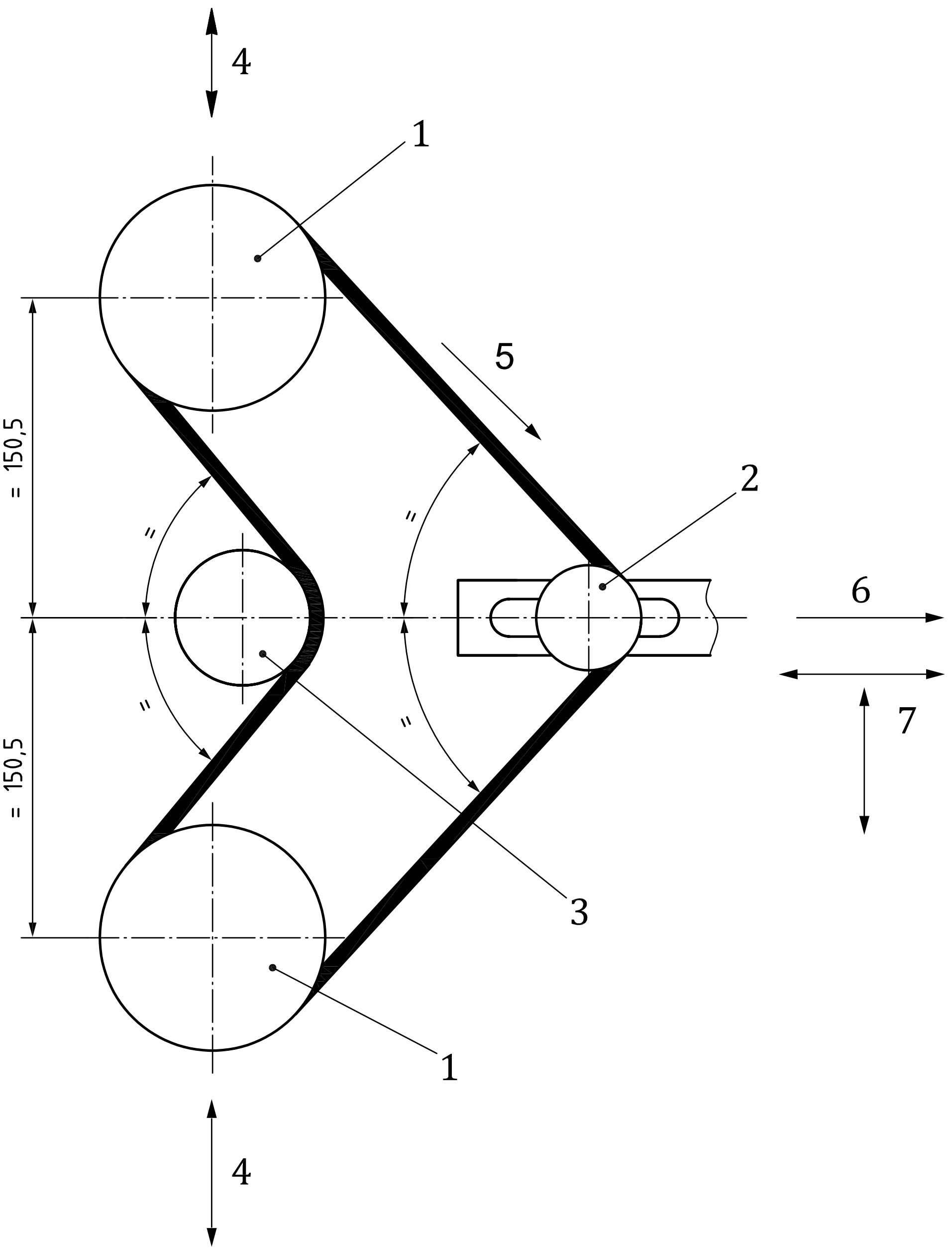
e) the number of running hours under test to satisfy the agreed conditions;

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.



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

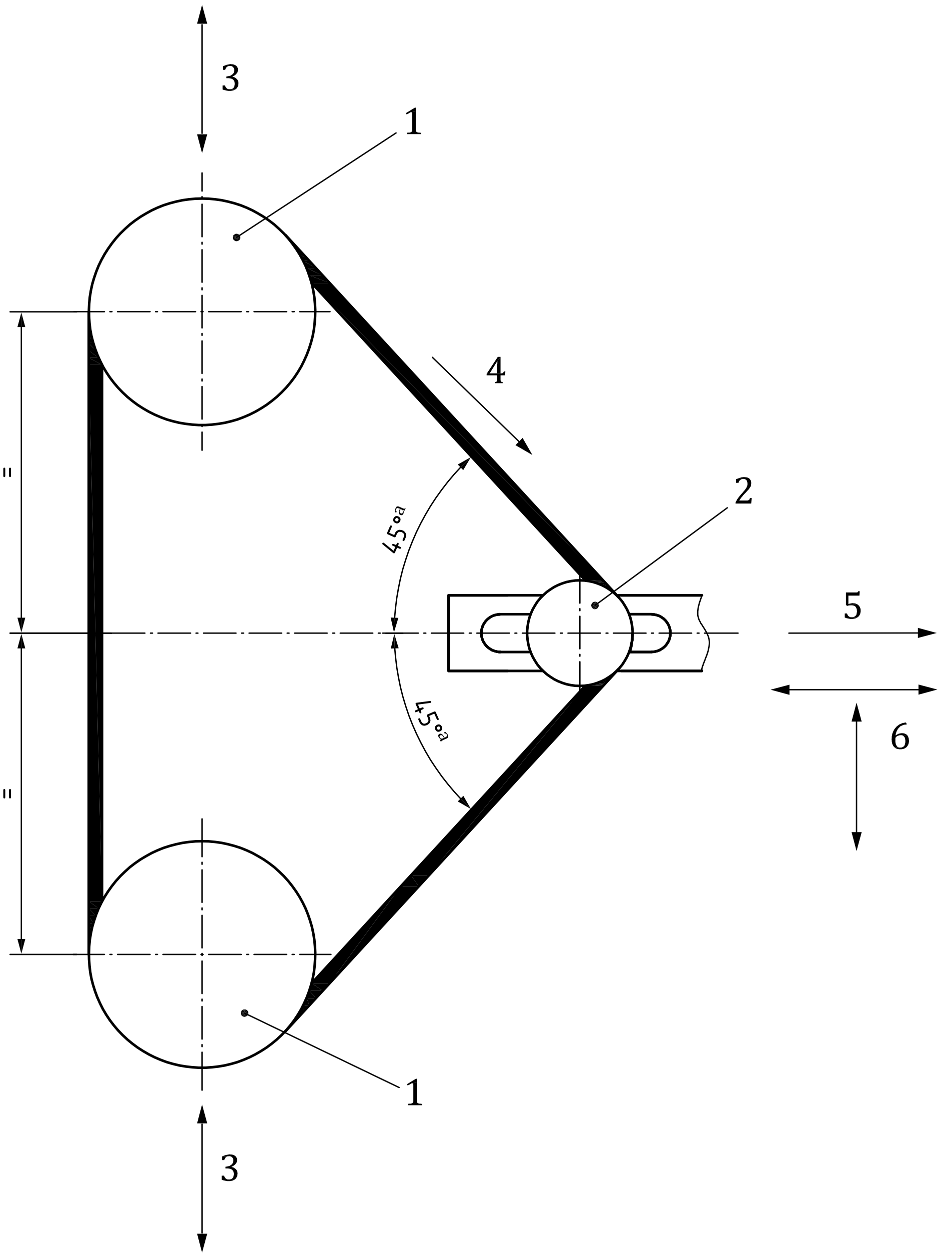
5 direction of rotation

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

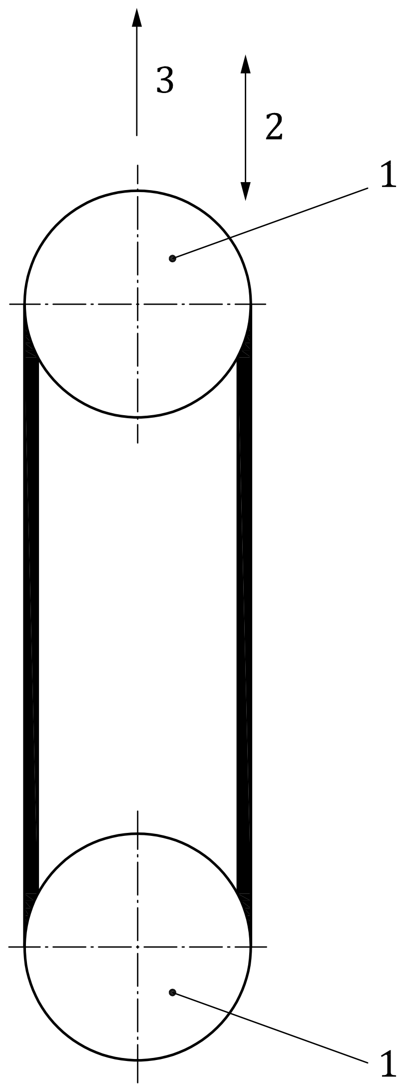
5 belt-tensioning force applied to the idler pulley

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 ±15' in relation to the plane through the centre of each pulley.



Key

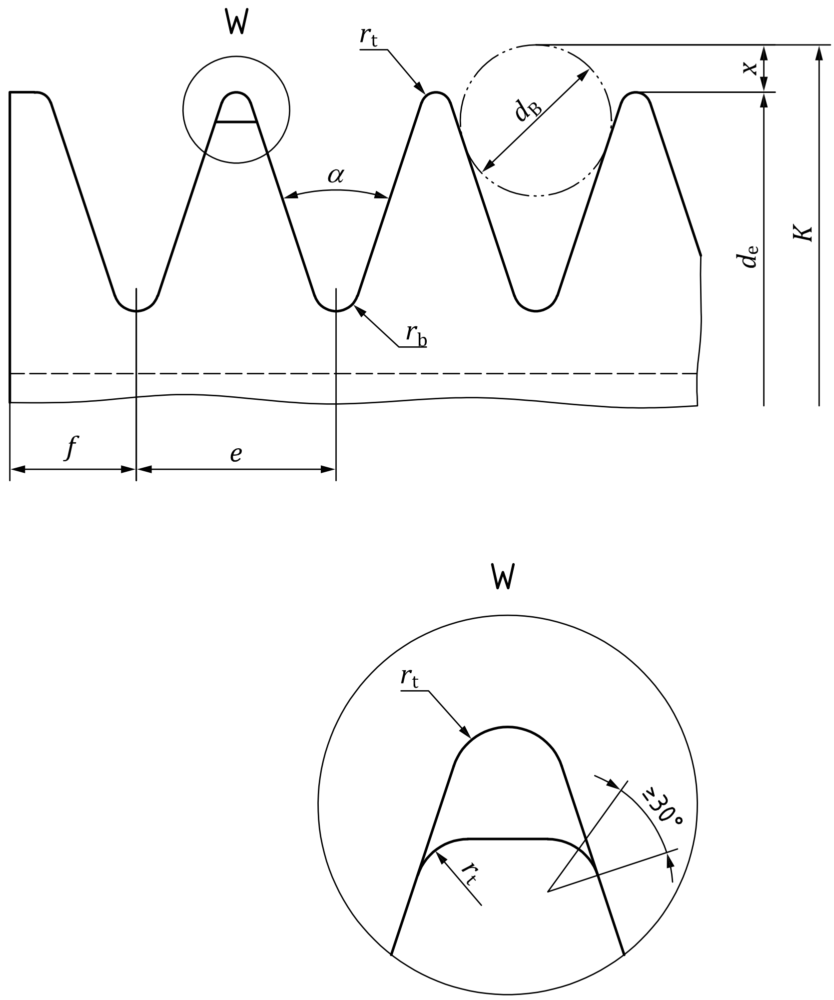
1 driven pulley (power-absorption unit)

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.



The actual configuration of the tip profile can lie anywhere between the maximum and minimum indicated. Any configuration shall have a transitional radius, r_{t}, corresponding to a 30° minimum arc tangent to the groove side wall (in accordance with ISO 9981).

Figure 4 — Cross-section of pulley grooves

Radial and axial circular runouts shall not exceed 0,25 mm total indicator reading (TIR). The runout in the two directions is measured separately with a ball mounted under spring pressure to ensure contact with the grooves as the pulley is rotated.

The pulley groove shall have a surface roughness *Ra* < 0,8 µm. (The value of 0,8 µm for *Ra* has been fixed because in this case it is a question of testing pulleys). See ISO 254 and ISO 468 for definitions and measurement method.

Table 1 — Dimensions of test pulleys

Parameter		Symbol	Dimension mm	Tolerance
Number of grooves			6	
Groove pitch		e	3,56	±0,05[a,b]
Groove angle[c]		α	40°	±0° 30′
Radius at the groove root[d]		r_b	0,5	$^{0}_{-0,15}$
Radius at the groove tip[d]		r_t	0,25	$^{+0,10}_{0}$
Effective diameter	Driving and driven pulleys[e]	d_{e1}	120,6	±0,2
	Idler pulley[e]	d_{e2}	60[f]	±0,2
	Driving and driven pulleys[g]	d_{e1}	63	±0,2
Outside diameter of reverse bending idler pulley[h]		d_{r3}	76,2[i]	±0,2
Pitch diameter[j]		d_p	$d_p = d_e + 2b_e$	
Effective line differential		b_e	2	nominal value
Diameter over balls or rods[k]		K	$K = d_e + 2\,x$	0,15
Position of the ball or rod to diameter d_B		$2x$	0,99	
Checking ball or rod diameter		d_B	2,5	±0,01
Lateral distance		f	>2,5	

[a] The tolerance on e applies to the distance between the axis of two consecutive grooves.

[b] The sum of all deviations from the nominal value e for all grooves in any one pulley shall not exceed ±0,3 mm.

[c] The centreline of the groove shall make an angle 90° ± 0,5° with the axis of the pulley.

[d] The tolerances on r_b and r_t are established in this International Standard (and not in ISO 9981) because in this case, it is a question of testing pulleys.

[e] In the case of the three- or four-pulley test machine.

[f] The value of 45 mm is the minimum recommended to better represent actual design practice in ISO 9981 and may be used for testing. The value of 55 mm may be selected to better represent actual design practice.

[g] In the case of the two-pulley test machine.

[h] In the case of the four-pulley test machine.

[i] No minimum reverse bend diameter is standardized. The value of 60 mm may be used for testing but should not be considered for production drives.

[j] The true pitch diameter of a V-ribbed pulley is slightly larger than the effective diameter, and its exact value is determined with the particular belt being used. A nominal value of the effective line differential b_e of 2 mm may be used to calculate the speed ratio. If more precision is required, the belt manufacturer should be consulted.

[k] The variation in diameters between the grooves in any one pulley shall not exceed 0,15 mm. This variation is obtained by comparing the diameters over balls or rods.

Bibliography

[1] ISO 254, *Belt drives — Pulleys — Quality, finish and balance*

[2] ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

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