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Synchronous belt drives — Automotive belts and pulleys

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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 of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 41, *Pulleys and belts (including vee belts)*, Subcommittee SC 4, *Synchronous belt drives*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This first edition of ISO 21342 cancels and replaces ISO 9010:1997 and ISO 9011:1997.

Synchronous belt drives — Automotive belts and pulleys

1 Scope

This document specifies the characteristics of synchronous endless belts and their related pulleys for use in automotive applications such as engine camshaft drives.

The characteristics include:

- belt pitch spacing;
- belt nominal tooth dimensions;
- belt width and width tolerance;
- belt pitch length and pitch length tolerance;
- pulley groove dimensions and tolerances;
- pulley tolerances and quality specifications.

Test methods for measuring belt pitch length and lateral runout are also included.

2 Normative reference

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 254, *Belt drives — Pulleys — Quality, finish and balance*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>.
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Profiles

The following profiles for synchronous drives for automotive applications are standardized:

- type ZA: trapezoidal tooth;
- type ZB: trapezoidal tooth;
- type ZH: curvilinear tooth, "H" system;
- type YH: curvilinear tooth, "H" system;
- type ZR: curvilinear tooth, "R" system;
- type YR: curvilinear tooth, "R" system;

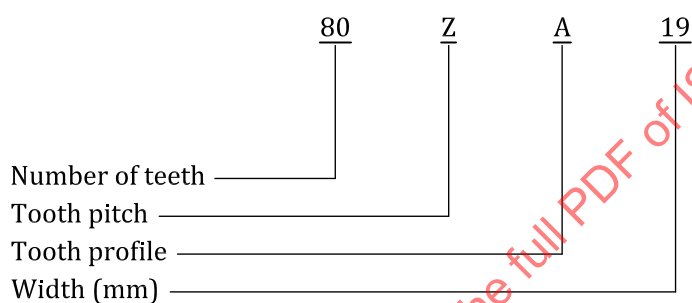
- type ZS: curvilinear tooth, "S" system;
- type YS: curvilinear tooth, "S" system.

5 Belt designation

A belt is designated by a series of numbers and letters as follows:

- a) the first set of numbers indicates the number of teeth;
- b) the first letter indicates tooth pitch;
- c) the second letter indicates tooth profile;
- d) The second set of numbers indicates the width in millimetres.

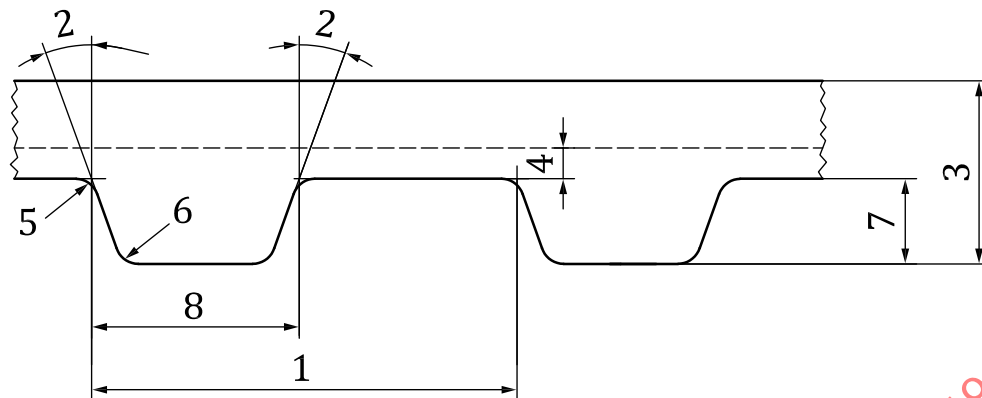
EXAMPLE



6 Belt dimensions and tolerances

6.1 Belt tooth dimensions — Trapezoidal tooth belts of types ZA and ZB

The nominal belt tooth dimensions for trapezoidal tooth belts of types ZA and ZB are shown in [Figure 1](#) and given in [Table 1](#).

**Key**

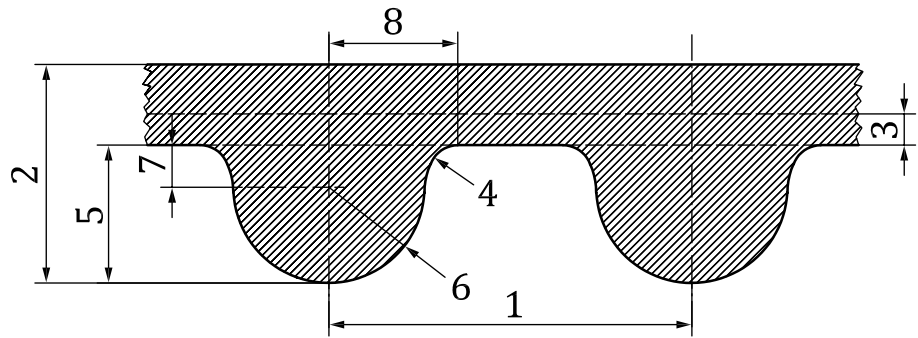
- 1 tooth pitch (p_b)
- 2 tooth angle (2β)
- 3 height (h_s)
- 4 pitch line differential (a)
- 5 root radius (r_r)
- 6 tip radius (r_a)
- 7 tooth height (h_t)
- 8 tooth width (S)

Figure 1 — Nominal tooth dimensions (profile) for types ZA and ZB**Table 1 — Nominal tooth dimensions for types ZA and ZB**

Key number	Symbol	Nominal profile	
		Type ZA	Type ZB
1	p_b	9,525	9,525
2	2β	40	40
3	h_s	4,1	4,5
4	a	0,686	0,686
5	r_r	0,51	1,02
6	r_a	0,51	1,02
7	h_t	1,91	2,29
8	S	4,65	6,12

6.2 Belt tooth dimensions — Curvilinear tooth belts of types ZH and YH

The nominal belt tooth dimensions for curvilinear tooth belts of types ZH and YH are shown in [Figure 2](#) and given in [Table 2](#).



Key

- 1 tooth pitch (p_b)
- 2 height (h_s)
- 3 pitch line differential (a)
- 4 root radius (r_r)
- 5 tooth height (h_t)
- 6 tooth radius (R)
- 7 vertical offset (Y)
- 8 root radius distance (S_r)

Figure 2 — Nominal tooth dimensions (profile) for types ZH and YH

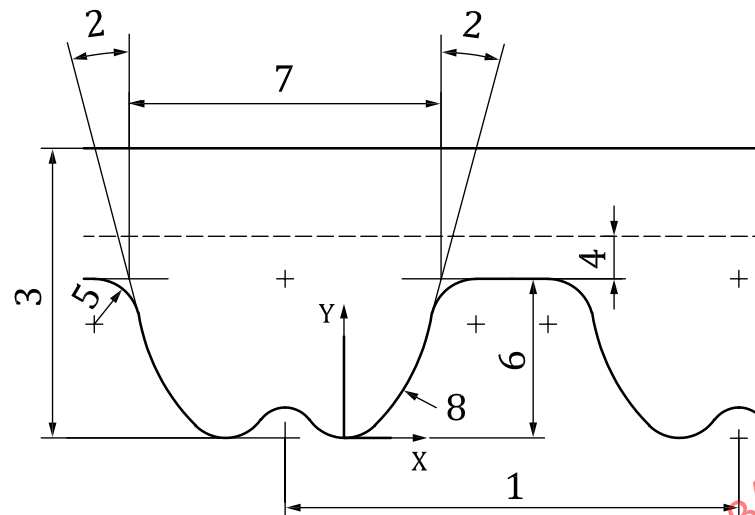
Table 2 — Nominal tooth dimensions for types YH and ZH

Dimensions in millimetres
Angles in degrees

Key number	Symbol	Nominal profile	
		Type YH	Type ZH
1	p_b	8	9,525
2	h_s	5,2	5,5
3	a	0,686	0,686
4	r_r	0,64	0,76
5	h_t	3,04	3,5
6	R	2,11	2,45
7	Y	0,93	1,05
8	S_r	2,84	3,27

6.3 Belt tooth dimensions — Curvilinear tooth belts of types YR and ZR

The nominal tooth dimensions for curvilinear tooth belts of types YR and ZR are shown in [Figure 3](#) and given in [Table 3](#).

**Key**

- 1 tooth pitch (p_b)
- 2 tooth angle (2β)
- 3 height (h_s)
- 4 pitch line differential (a)
- 5 root radius (r_r)
- 6 tooth height (h_t)
- 7 tooth width (S)
- 8 $Y = kX^2$

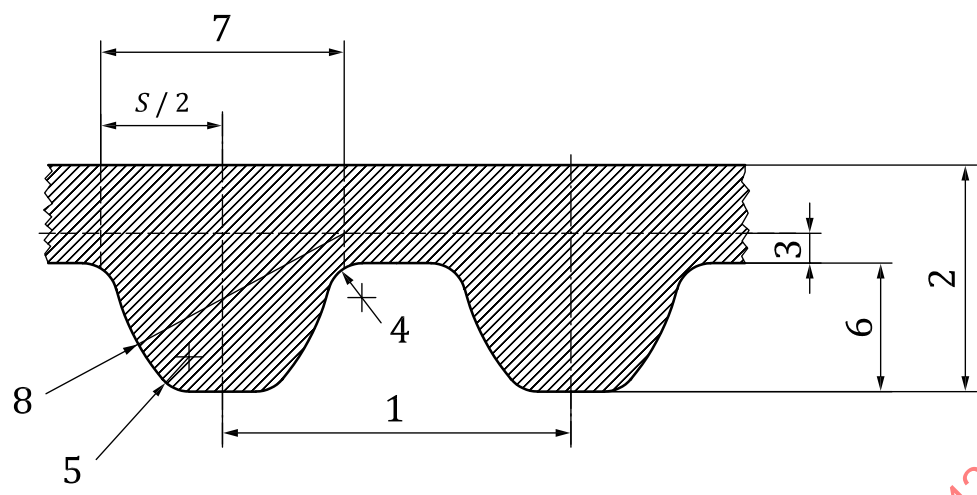
Figure 3 — Nominal tooth dimensions (profile) for YR and ZR**Table 3 — Nominal tooth dimensions for types YR and ZR**

Dimensions in millimetres
Angles in degrees

Key number	Symbol	Nominal profile	
		Type YR	Type ZR
1	p_b	8	9,525
2	2β	30	32
3	h_s	5,1	5,4
4	a	0,75	0,75
5	r_r	0,8	1,00
6	h_t	2,8	3,2
7	S	5,3	5,5
Tooth form parameter		1,692	1,228

6.4 Belt tooth dimensions — Curvilinear tooth belts of types YS and ZS

The nominal tooth dimensions for curvilinear tooth belts of types YS and ZS are shown in [Figure 4](#) and given in [Table 4](#).



- Key**
- 1 tooth pitch (p_b)
 - 2 height (h_s)
 - 3 pitch line differential (a)
 - 4 root radius (r_r)
 - 5 tip radius (r_a)
 - 6 tooth height (h_t)
 - 7 tooth width (S)
 - 8 tooth radius (R)

Figure 4 — Nominal tooth dimensions (profile) for types YS and ZS

Table 4 — Nominal tooth dimensions for types YS and ZS

Dimensions in millimetres
Angles in degrees

Key number	Symbol	Nominal profile	
		Type YS	Type ZS
1	p_b	8	9,525
2	h_s	5,2	5,7
3	a	0,686	0,686
4	r_r	0,8	0,95
5	r_a	0,8	0,95
6	h_t	2,95	3,53
7	S	5,2	6,19
8	R	5,2	6,19

6.5 Belt pitch length and tolerances

Belt pitch length is defined by the number of teeth multiplied by tooth pitch, p_b . The belt pitch length, L_p , shall be agreed between the parties concerned. Pitch length tolerances are given in [Table 5](#).

Table 5 — Pitch length tolerances

Dimensions and tolerances in millimetres

Pitch length L_p	
Range	Tolerance
$L_p \leq 381$	$\pm 0,45$
$381 < L_p \leq 505$	$\pm 0,50$
$505 < L_p \leq 762$	$\pm 0,60$
$762 < L_p \leq 991$	$\pm 0,65$
$991 < L_p \leq 1\,220$	$\pm 0,75$
$1\,220 < L_p \leq 1\,524$	$\pm 0,80$
$1\,524 < L_p \leq 1\,782$	$\pm 0,85$
$1\,782 < L_p \leq 2\,030$	$\pm 0,90$
$2\,030 < L_p \leq 2\,286$	$\pm 0,95$
$2\,286 < L_p \leq 2\,544$	$\pm 1,00$

6.6 Belt widths and tolerances

The belt width, b_s shall be agreed between the parties concerned. Width tolerances are given in [Table 6](#).

Table 6 — Width tolerances

Dimensions and tolerances in millimetres

Range	Width, b_s	
	Tolerance	
	Pitch length	
	$L_p < 840$	$L_p \geq 840$
$b_s < 40$	$\pm 0,8$	$\pm 0,8$
$b_s \geq 40$	$\pm 0,8$	+0,8 -1,3

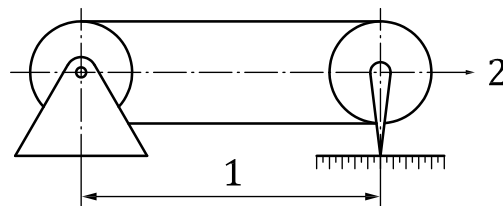
NOTE Smaller tolerances can be used as agreed between customer and supplier.

7 Pitch length measurement

7.1 Measuring fixture

The pitch length of a synchronous belt shall be determined by placing the belt on a measuring fixture composed of the following elements (see [Figure 5](#)).

- Two pulleys of equal diameter, as specified in [Table 7](#) of the proper belt type and having standard tooth space dimensions. These pulleys should be made to the tolerances shown in [Table 7](#) and [Tables 8, 9](#) or [10](#), as appropriate. One pulley shall be free to rotate on a fixed-position shaft, while the other shall be free to rotate on a movable shaft to permit the centre distance to change.
- Means of applying a total measuring force to the movable pulley.
- Means of measuring the centre distance between the two pulleys with the necessary degree of accuracy to check the allowed tolerances (tolerances for centre distance measurement should be one-half of the allowed length tolerances in [Table 5](#)).

**Key**

- 1 centre distance
2 total measuring force, F_t

Figure 5 — Pitch length measuring fixture**Table 7 — Belt pitch length measuring pulleys**

Dimensions and tolerances in millimetres

Belt type	Number of teeth	Pitch circumference	Outside diameter	Runout		$2a$
	z	$p_b \times z$	d_o	radial	axial	
ZA, ZB, ZH, ZS	20	190,5	$59,266 \pm 0,013$	0,013	0,025	1,372
YH, YS	22	176	$54,651 \pm 0,013$	0,013	0,025	1,372
ZR	20	190,5	$59,138 \pm 0,013$	0,013	0,025	1,5
YR	22	176	$54,522 \pm 0,013$	0,013	0,025	1,5

NOTE Pulleys of other diameters can be used provided that the diameters of the two pulleys are equal and that they are larger than those specified in [Table 7](#).

7.2 Total measuring force

The total measuring force, F_t , to be applied for measuring belts shall be calculated with [Formulae \(1\)](#) and [\(2\)](#):

- Types ZA, ZB, ZH, YH, ZR and YR:

$$F_t = (b_s \times 29) - 100 \quad (1)$$

- Types ZS and YS:

$$F_t = 1\,020 \times (b_s / 25)^{1,14} \quad (2)$$

where

b_s is the width in millimetres;

F_t is the total force, in newtons.

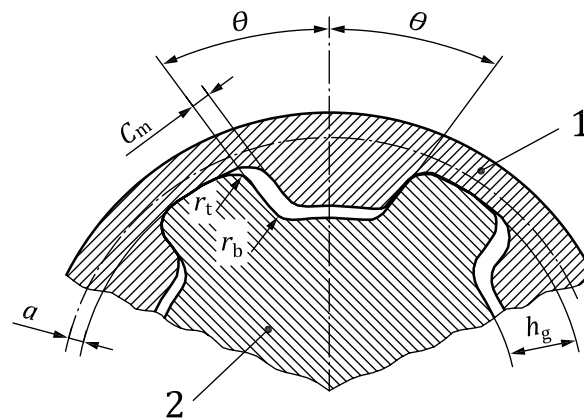
7.3 Procedure

When measuring the pitch length of a synchronous belt, the belt should be rotated at least two revolutions to seat it properly and to divide the total force equally between the two strands of the belt.

The pitch length shall be calculated by adding the pitch circumference of one of the pulleys to twice the measured centre distance.

7.4 Dimensions and clearance between measuring pulley and belt, and measuring pulley grooves

See [Figures 6 to 11](#) and [Tables 8 to 11](#).



Key

- 1 belt
- 2 pulley

Figure 6 — Dimensions and clearance between measuring pulley and belt for types ZA and ZB
(see [Table 8](#))

Table 8 — Dimensions of measuring pulley grooves for types ZA and ZB (see [Figure 6](#))

Dimensions in millimetres
Angle in degrees

Type	Minimum clearance C_m	h_g	r_b	r_t	θ	a
ZA	0,33	$2,68 \pm 0,1$	$0,85 \pm 0,1$	$0,85 \pm 0,1$	$20 \pm 1,5$	0,686
ZB	0,38	$3 \pm 0,1$	$1,23 \pm 0,1$	$1,23 \pm 0,1$	$20 \pm 1,5$	0,686

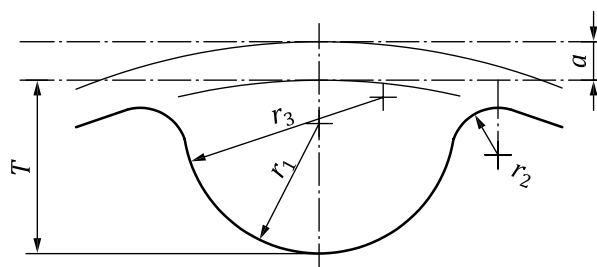
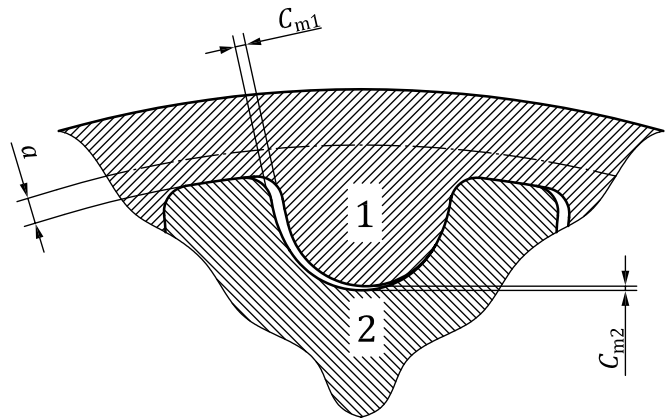


Figure 7 — Measuring pulley grooves for types YH and ZH (see [Table 9](#))



- Key**
- 1 belt
 - 2 pulley

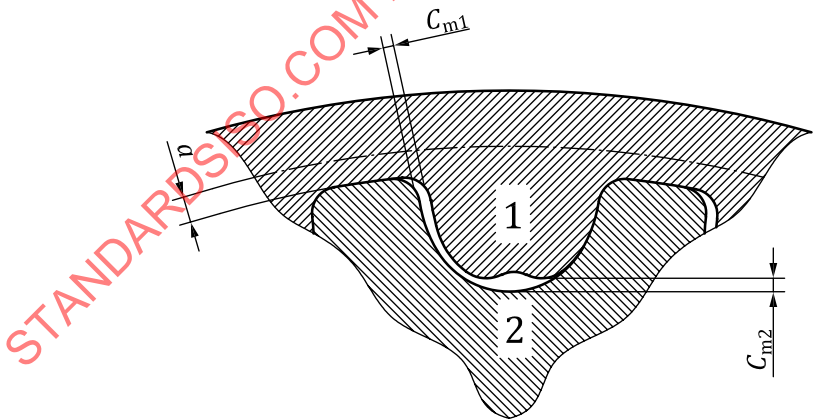
Figure 8 — Clearance between measuring pulley and belt types YH and ZH (see Table 9)

Table 9 — Dimensions of measuring pulley grooves for types YH and ZH (see Figures 7 and 8)

Dimensions in millimetres

Type	a	Minimum clearance		r_1	r_2	r_3	T
		C_{m1}	C_{m2}	$\pm 0,05$	$\pm 0,05$	$\pm 0,05$	$\pm 0,05$
YH	0,686	0,3	0,11	2,22	0,69	3,45	3,16
ZH	0,686	0,34	0,11	2,78	0,89	a	3,61

^a Blend radius r_3 is not used on ZH section.



- Key**
- 1 belt
 - 2 pulley

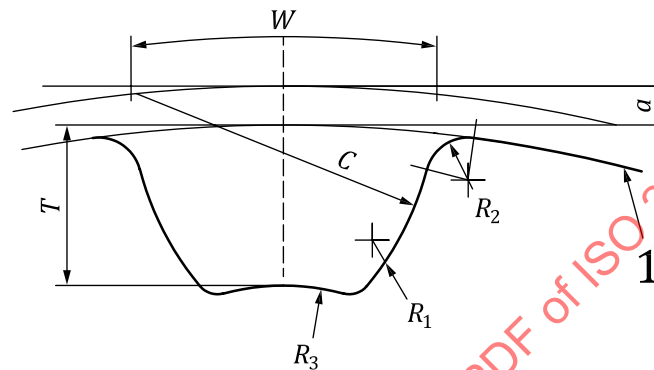
Figure 9 — Clearance between measuring pulley and belt types YR and ZR (see Table 10)

Table 10 — Clearance between measuring pulley and belt types YR and ZR (see [Figure 9](#))

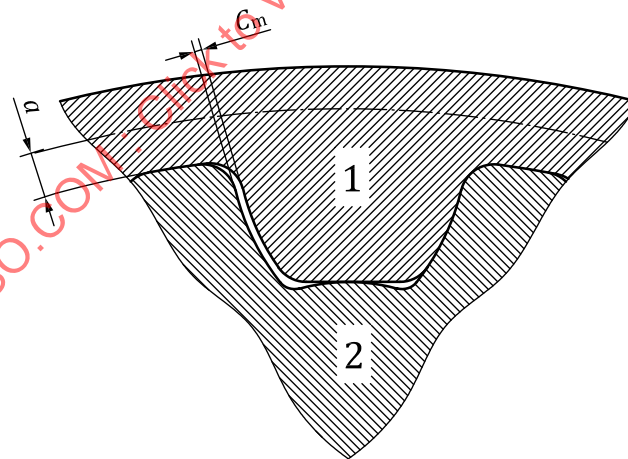
Dimensions in millimetres

Type	Number of teeth	Minimum clearance		a
	z	C_{m1}	C_{m2}	
YR	22	0,3	0,11	0,75
ZR	20	0,34	0,11	0,75

NOTE The pulley groove profile dimensions are determined by the generating tool rack described in [Figure 17](#) and [Table 14](#).

**Key**

1 pulley outside diameter

Figure 10 — Measuring pulley grooves for types YS and ZS (see [Table 11](#))**Key**

1 belt

2 pulley

Figure 11 — Clearance between measuring pulley and belt for types ZS and YS (see [Table 11](#))

Table 11 — Dimensions of measuring pulley grooves for types YS and ZS (see Figures 10 and 11)

Dimensions in millimetres

Type		Minimum clearance						
	a	C_m	W +0,1 0	C +0,1 0	T $\pm 0,03$	R_1 $\pm 0,05$	R_2 +0,05 0	R_3 $\pm 0,05$
YS	0,686	0,24	5,2	5,3	2,83	0,4	0,75	4,04
ZS	0,686	0,2	6,19	6,31	3,37	0,48	0,89	4,81

8 Lateral runout measurement

8.1 Fixture

8.1.1 Belt

The lateral run out of a synchronous belt shall be measured using the same machine described in [Clause 6](#) and shown in [Figure 5](#). The total force shall be as specified in [6.2](#).

8.1.2 Pulleys

The number of grooves and groove dimensions shall be as specified in [6.1](#) and [Table 7](#) for pitch length measuring.

The fixed position pulley (driving pulley) shall be flanged on both sides. The width between flanges shall be at least 2 mm wider than the belt being measured. The movable pulley shall be unflanged and of width at least 25 mm wider than the flanged pulley face (see [Figure 12](#)).

8.2 Measuring device

Sensors of either mechanical or optical type are positioned at a point 125 mm from the centreline of the unflanged pulley and on the strand of the belt entering the unflanged pulley. A single sensor may be used, or sensors may be placed on each side of the belt.

NOTE Belts of 690 mm length or shorter can require optional sensor location as agreed between customer and supplier.

8.3 Procedure

Place the belt on the measuring device as shown in [Figure 12](#) with the label as shown, readable from the front of the fixture.

Position the sensor(s) at the edge of the belt at a position of 125 mm from the centreline of the unflanged, movable pulley. Rotate the belt clockwise at least two revolutions after reaching a stable position against a flange.

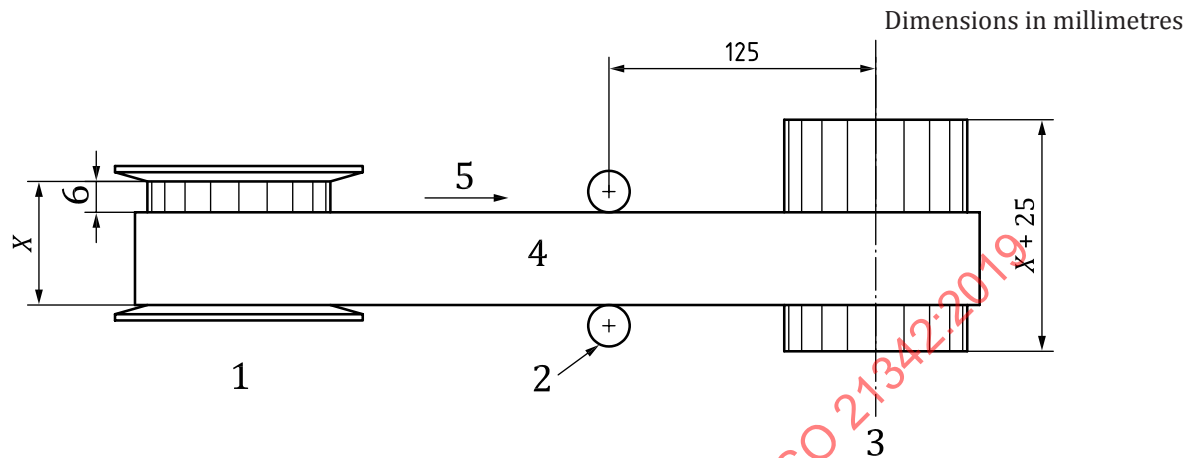
As the belt rotates the edge of the belt moves axially with respect of the sensor(s). The lateral runout is measured at the sensor on the edge of the belt which is in contact with the flange.

8.4 Results

The sensor shall measure full indicator movement (FIM) and shall be manually or automatically recorded to the nearest 0,1 mm. This measurement method provides a single lateral runout measurement for the belt.

Values should be agreed on between customer and supplier.

NOTE The reading which is taken as lateral runout is a combination of the static or dimensional characteristic "width variation" and the dynamic characteristic "lateral runout".



Key

- 1 fixed driving pulley
- 2 runout sensors
- 3 moveable pulley
- 4 label
- 5 direction of rotation

Figure 12 — Lateral runout measuring fixture (top view)

9 Pulley types

The following types of synchronous pulleys for automotive applications are standardized and are in line with the belts which match them:

- type ZA: trapezoidal tooth;
- type ZB: trapezoidal tooth;
- type ZH: curvilinear tooth, "H" system;
- type YH: curvilinear tooth, "H" system;
- type ZR: curvilinear tooth, "R" system;
- type YR: curvilinear tooth, "R" system;
- type ZS: curvilinear tooth, "S" system;
- type YS: curvilinear tooth, "S" system.

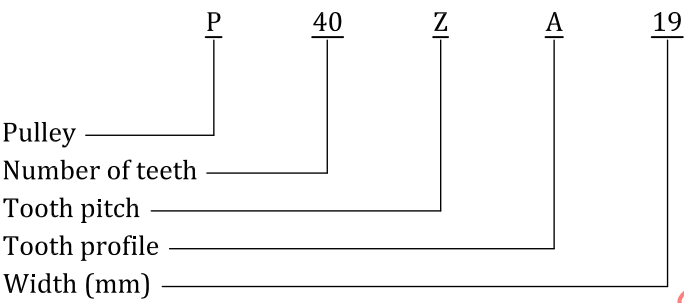
10 Pulley designation

A pulley for a synchronous drive for automobiles is characterized by the number of grooves, the groove pitch and profile and the width. It is identified, as is the belt, by a series of numbers and letters as follows:

- the first letter "P" indicates a pulley;

- the first set of numbers indicates the number of grooves;
- the second letter indicates groove pitch;
- the third letter indicates groove profile;
- the second set of numbers indicates the corresponding nominal belt width in millimetres (see 12.3 for the actual pulley width recommended).

EXAMPLE



11 Pulley groove profile

11.1 Pulleys of types ZA and ZB (involute groove profile)

Dimensions and tolerances for the generating tool rack for the involute profile of automotive synchronous pulleys of types ZA and ZB are given in Table 12 and shown in Figure 13.

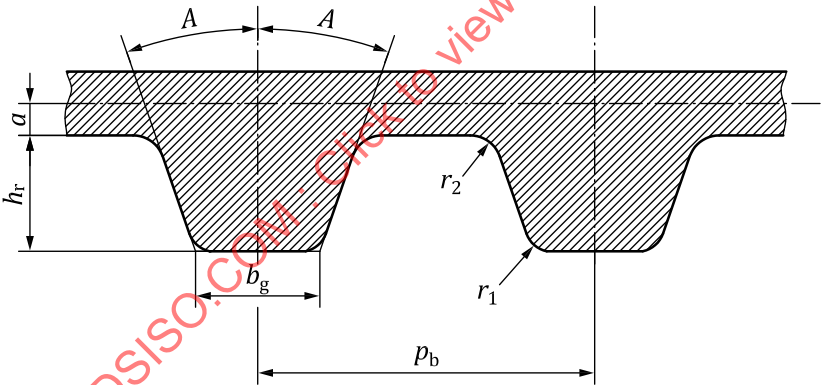


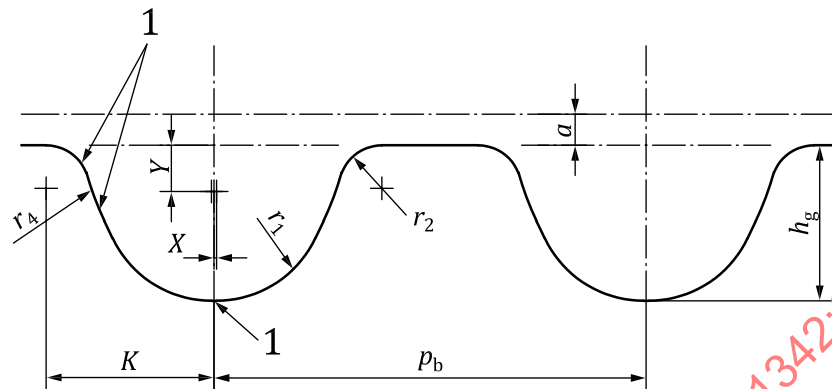
Figure 13 — Generating tool rack for types ZA and ZB

Table 12 — Generating tool rack dimensions and tolerances for types ZA and ZB

Dimensions in millimetres Angle in degrees								
Type	Number of teeth in pulley <i>z</i>	<i>p_b</i>	<i>A</i>	<i>h_r</i>	<i>b_g</i>	<i>r₁</i>	<i>r₂</i>	<i>a</i>
		±0,012	±0,12	+0,05 0	+0,05 0	±0,03	±0,03	
ZA	<i>z</i> ≥ 19	9,525	20	2,13	3,1	0,86	0,71	0,686
ZB	19 ≤ <i>z</i> ≤ 20	9,525	20	2,59	4,24	1,47	1,04	0,686
	<i>z</i> ≥ 21						1,42	

11.2 Pulleys of types ZH and YH

Dimensions and tolerances for the generating tool rack for automotive synchronous pulleys of types ZH and YH are given in Table 13 and shown in Figures 14, 15 and 16.



Key

1 blend

Figure 14 — Generating tool rack for type ZH (17 through 26 teeth)

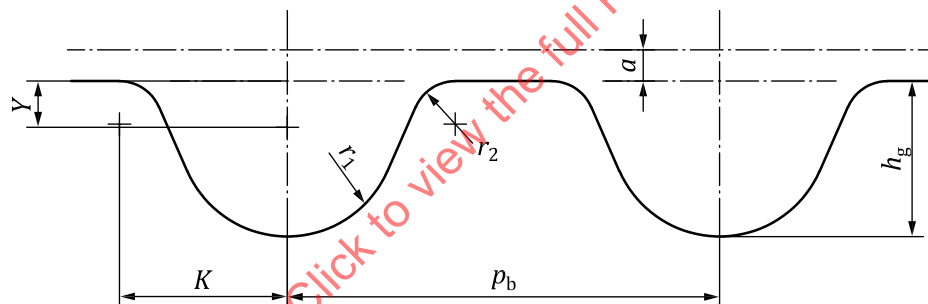


Figure 15 — Generating tool rack for type ZH (27 through 52 teeth)

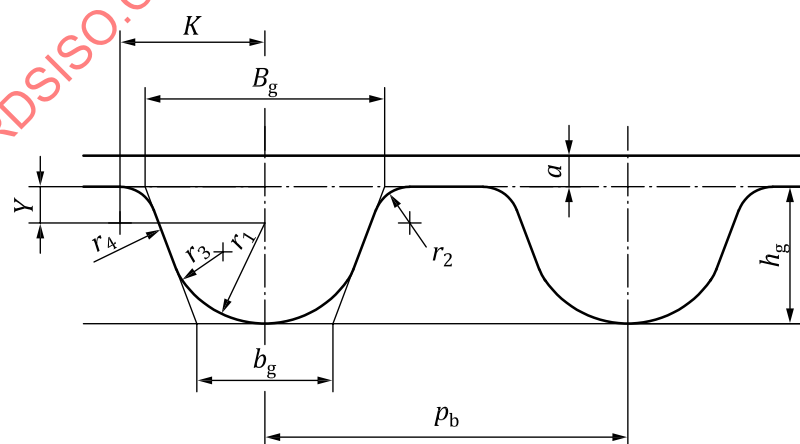


Figure 16 — Generating tool rack for type YH

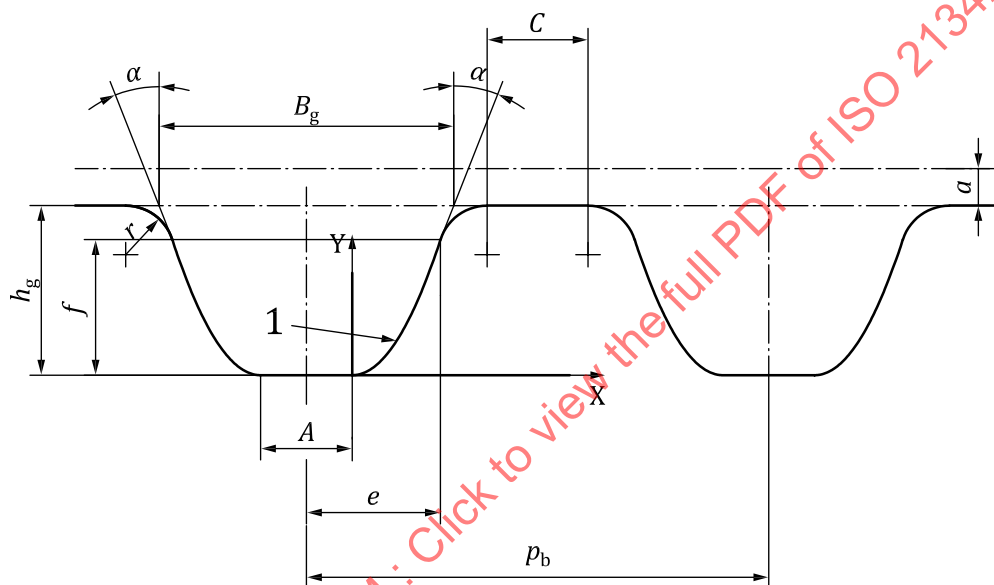
Table 13 — Generating tool rack dimensions and tolerances for types ZH and YH

Dimensions in millimetres

Type	Number of teeth in pulley z	p_b	B_g	b_g	h_g	r_1	r_2	r_3	r_4	X	Y	K	a
		$\pm 0,012$			$\pm 0,015$	$\pm 0,012$	$\pm 0,012$	$\pm 0,012$	$\pm 0,012$				
ZH	$17 \leq z \leq 26$	9,525			3,43	2,41	0,95		6,67	0,058	1,02	3,7	0,686
	$27 \leq z \leq 52$	9,525			3,44	2,5	0,95				0,94	3,61	0,686
YH	$20 \leq z \leq 31$	8	5,28	3	3,02	2,22	0,8	2	1,5		0,80	3,22	0,686
	$z \geq 32$	8	5,08	3,11	3,06	2,17	0,67		1,1		0,89	3,06	0,686

11.3 Pulleys of types ZR and YR

Dimensions and tolerances for the generating tool rack for automotive synchronous pulleys of types ZR and YR and given in [Table 14](#) and shown in [Figure 17](#).



Key

1 $Y = kX^2$

Figure 17 — Generating tool rack for types ZR and YR**Table 14 — Generating tool rack dimensions and tolerances for types ZR and YR**

Dimensions in millimetres

Angles in degrees

Type	Number of teeth in pulley z	p_b $\pm 0,01$	B_g $+0,05$ -0	A	C	a	h_g $\pm 0,02$	r	α	Tooth form parameter k	e	f
ZR	$z \geq 20$	9,407	5,9	1,865	2,053	0,75	3,45	1	18	0,858	2,726	2,759
YR	$20 \leq z \leq 29$	7,786	5,6	2,788	0,959	0,75	2,92	0,8	15	1,496	2,641	2,327
	$z > 29$	7,893	5,6	2,788	1,066	0,75	2,92	0,8	15	1,496	2,641	2,327

11.4 Pulleys of types ZS and YS

Dimensions and tolerances for the pulley groove profile automotive synchronous pulleys of types ZS and YS are given in [Table 15](#) and shown in [Figure 18](#).